DOCUMENT RESUME

ED 255 754 CE 041 301

TITLE Machine Shop. Student Learning Guide.
INSTITUTION Palm Beach County Board of Public Instruction, West Palm Beach, Fla.
SPONS AGENCY Florida State Dept. of Education, Tallahassee. Div. of Vocational Education.
PUB DATE 84
NOTE 155p.; For related documents, see CE 041 296-303.
PUB TYPE Guides - Classroom Use - Materials (For Learner) (051)

EDRS PRICE MF01/PC07 Plus Postage.
DESCRIPTORS Behavioral Objectives; Competency Based Education; Course Content; *Job Skills; *Learning Activities; Learning Modules; Machine Tool Operators; *Machine Tools; *Machinists; *Manufacturing Industry; Mechanical Equipment; Mechanics (Process); Metal Working; Secondary Education; Sheet Metal Work; Test Items; *Trade and Industrial Education; Vocational Education

ABSTRACT

This student learning guide contains eight modules for completing a course in machine shop. It is designed especially for use in Palm Beach County, Florida. Each module covers one task, and consists of a purpose, performance objective, enabling objectives, learning activities and resources, information sheets, student self-check with answer key, performance test, instructional resources, and knowledge test. The eight modules cover the following topics: filing; using a vertical band saw; operating a Bridgeport J-Head; performing hand grinding with a drill; counterboring, countersinking, and spotfacing using drills; using a three-jaw chuck in operating a lathe; using the knurling technique in lathe work; and performing taper turning by the offset method on a lathe. (KC)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED255754

STUDENT LEARNING GUIDE

FL841311

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

DUTY

TASK

PREREQ

DEPC

PROG.

REVISED

PROGRAM: MACHINE SHOP

DUTY: C COMPLETING CORE CURRICULUM

TASK: 1 3 Practice Filing

PURPOSE:

The file can be a precision cutting tool. An expert can use a file as a substitute for many other cutting tools. This learning guide will give you some information on how to do filing on work held in a vise or a lathe.

U.S. DEPARTMENT OF EDUCATION
NATIONAL INSTITUTE OF EDUCATION
EDUCATIONAL RESOURCES INFORMATION
CENTER (ERIC)

✓ This document has been reproduced as received from the person or organization originating it.

Minor changes have been made to improve reproduction quality.

- Points of view or opinions stated in this document do not necessarily represent official NIE position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY

D McQuat

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

CE041301

PLEASE DO NOT WRITE IN LEARNING GUIDE

BEST COPY AVAILABLE

1

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

OBJECTIVES

DUTY

TASK

DEPT.

PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance, and standard)

GIVEN: access to files, file cards, vise and lathe,

YOU WILL: use filing

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Describe the types of filing operations on a bench vise.
2. Practice filing.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1 number PAGE 4 OF 15

DUTY

TASK

EN OBJ

DEPT

PROG

Enabling objective

Describe the types of filing operations on a bench vise.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1 describe the techniques of filing.	1. a. Instruction Sheet enclosed, Using a File b. Text: Machine Tool Operations Visutext, pages 82-83.
2. Complete the Self-Check.	2. Self-Check enclosed.
3. When you think you can attain this task take the Knowledge Test.	3. Knowledge Test.
4. Go on to Enabling Objective No. 2.	

Using a File

Selecting a File

Before a person can choose a file, he must know what is available. The correct file to use is determined by many factors.

Kind of job: filing a flat surface
filing a curved surface (convex or concave)
filing an edge
filing a slot or notch
filing a square or round hole.
(The SHAPE of the file must be considered for these factors.)

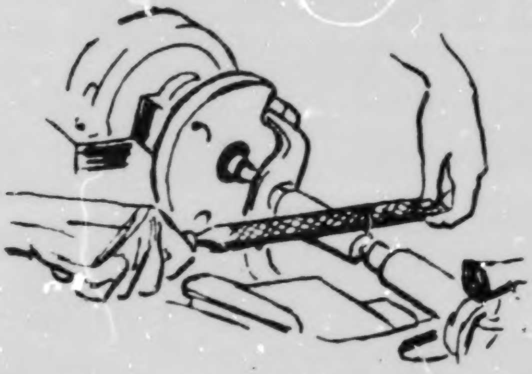
Properties of the work: its hardness
its size
nature of material
(The COARSENESS and CUT of the file must be considered for these factors.)

Manner of filing: quantity of stock to be removed
heaviness or lightness of cut
depth of cut
speed of stock removal
accuracy of smoothness desired
(The LENGTH, SHAPE, CUT and COARSENESS of the file are all consideration for these factors.)

Lathe Filing

The file should not be used to improve the finish of a part made in a lathe. A well ground tool bit should do this. A file is primarily used to remove a sharp edge or to correct a slight taper in the work. Since another cut on the lathe may result in the work being made undersize, a file will do the job. Unless lathe filing is done properly, it will do more harm than good. Use a LONG-ANGLE LATHE FILE or a SINGLE-CUT MILL BASTARD FILE.

The speed of the lathe should be decreased about 50% lower than that for regularly turning the work of the same diameter. BE SURE YOU HAVE NO LOOSE CLOTHES THAT MAY CATCH ON THE REVOLVING PARTS. Hold the file at a slight angle and use a long, steady forward stroke. Move the file sideways about half its width every stroke. Do not hold the file in one place or the teeth will load up there and scratch the finish. Clean the file frequently with a file card or a brush. Apply chalk occasionally to prevent clogging of the teeth.



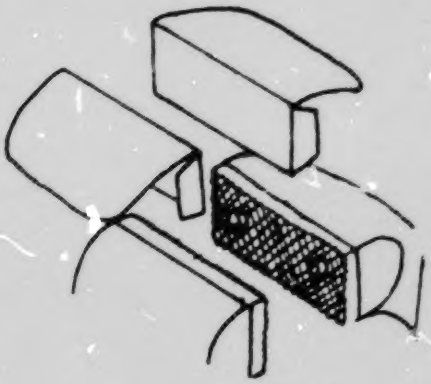
How to File

1. Most work that is filed is held in a VISE. This eliminates chatter and vibration that causes the depth of cut to vary. The top of the vise should be on the same level as the elbow so that the arms can make flat strokes without rocking the file. For small and delicate work, the vise and work should be higher. This allows the person to see better and to accurately guide the file. For heavy filing, the work should be lower so the person can exert more pressure on the file with less effort.
   To protect highly finished work, the serrated jaws of the vise should be covered with a soft metal such as copper or brass.
   See pictures next page.

2. Worker's stance: The feet should be placed well apart with the front foot pointing toward the work. You should have full swing of the arms from the shoulder.

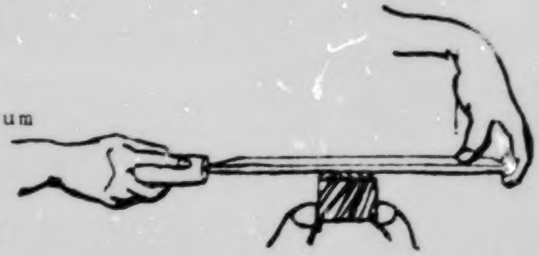
BEST COPY AVAILABLE

3. Gripping the file: The handle is rested in the palm of the right hand and the fingers wrapped around it. The top of the file is gripped with the thumb on top and the fingers wrapped around the end.

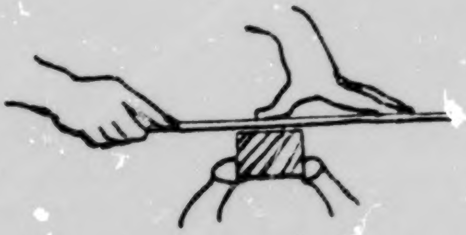


For flat filing the thumb and fingers of the left hand are stretched far apart and press evenly on the file. This assures a uniform distribution of the pressure over the whole length. Any unevenness can be easily detected.

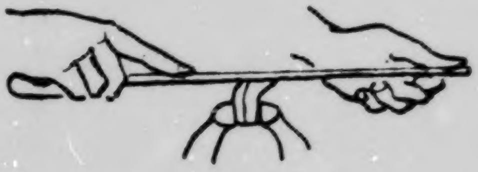
For accurate work, the tip of the file is held by just the thumb and index finger of the left hand. This allows maximum guidance and control.



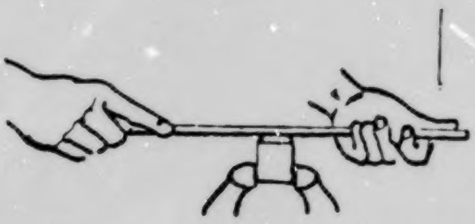
For heavy stock removal, the thumb of the left hand is run along the length of the file and the fingers are wrapped around the file. This allows you to exert a greater downward force but limits the area of the file that can be used.



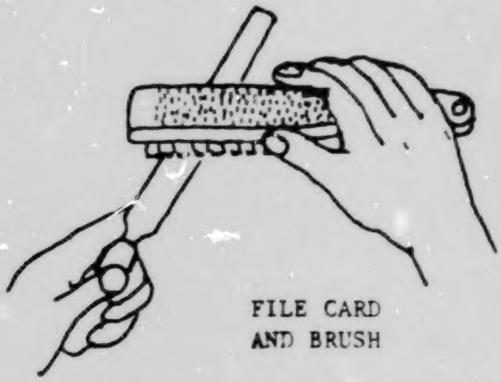
4. Stroke and pressure: The teeth of the file cut only on the forward stroke. If pressure is applied on the return stroke, the teeth will be dulled. Except on soft metals, the file should be lifted clear of the work. Use the full length of the files so that it does not become dull in the middle only.



Just enough pressure should be applied to keep the file cutting. Too much pressure clogs or breaks the teeth. Not enough pressure allows the teeth to slide over the work, dulling them.

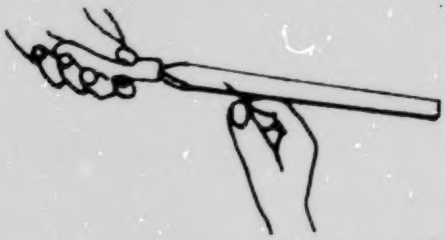


5. Beginner's faults: The main fault is that beginners allow the file to rock on the work. This produces a convex surface instead of a flat one. To avoid this, the body should be kept still and the arms made to pivot at the shoulders. Also, the operator should not try to remove too much metal in one stroke.



FILE CARD AND BRUSH

Make sure the file is clean before starting. If dirty, it can easily be cleaned with a file card. Any pieces that will not come out can be removed with a piece of wire or sheet metal.

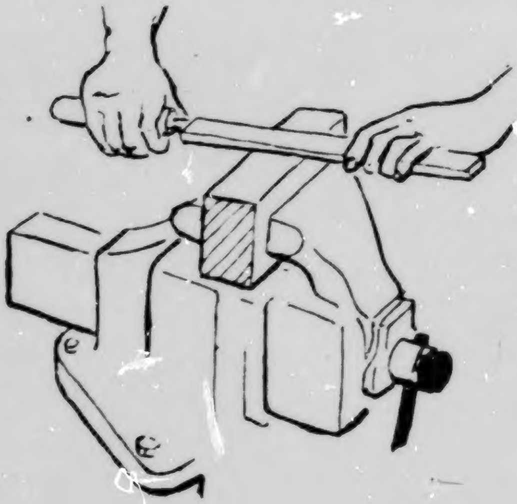


REMOVING PINS

When a new file is used, rub it with chalk to keep the teeth from clogging. This also is an advantage during finishing cuts, otherwise the pins that stick in the file would scratch the work. Never use a file without a handle, the TANG may injure your hand.

Draw Filing

Draw filing is done to get a finely finished surface. The file is held with both hands with the fingers on the edge away from the body and the thumbs on the edge toward the body. Draw the file back and forth on the work, pressing down only on the forward stroke. A SINGLE-CUT MILL BASTARD file or a LONG-ANGLE LATHE file is used so that the metal is cut with a shaving action.



The beginner has a tendency to apply more pressure in the middle of the stroke. This produces a hollow spot. Check the work with a STRAIGHT EDGE.
Remove the hollow area by applying a few strokes at the end of the work.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number PAGE 9 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. Why should work be held in a vise when it is being filed?
2. How is the work protected from the serrated jaws of the vise?
3. Why are the thumb and fingers stretched over the top of the file for flat filing?
4. How is the tip of the file held for accurate filing?
5. In which direction does the file cut?
6. How much pressure should be applied to the file for filing?
7. What is used to clean a file?
8. Why is chalk put on a new file?
9. What is draw filing? What file is used?
10. In what direction does the file cut for draw filing?
11. When is filing done on work held in the lathe?
12. What file is used for filing work in a lathe?
13. What speed should be used for filing work in the lathe?

Now check your answers with the Answer Key.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number
ANSWER KEY

PAGE 10 OF 15

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

1. It supports the work at the right height and keeps it from chattering.

2. The jaws are covered with a soft metal such as copper or brass .

3. This gives you a sensitive feel of any unevenness and allows an even distribution of pressure.

4. The tip is held with the thumb and index finger.

5. On the forward (away from you) stroke.

6. Just enough pressure will clog and break teeth. Too little polishes the cutting edges and dulls them.

7. A file card and brush. A piece of wire or sheet metal will push pins from teeth.

8. It keeps the teeth from loading up.

9. Draw filing is done to put a good finish on the work and make it flat. A single-cut mill bastard file or a long-angle lathe file is used.

10. On the forward stroke.

11. Filing in a lathe is done to remove sharp edges and to remove slight taper in work.

12. A long-angle lathe file or a single-cut mill bastard file.

13. The speed should be 1/2 the speed used for turning the same diameter stock.

All of your answers should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2 number PAGE 11 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective

Practice filing.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1 practice filing.	1. a. File b. File card c. Vise d. Lathe
2. Complete the Self-Check. Have your instructor check your work.	2.
3. When you think you can perform this task, take the Performance Test.	3. a. Performance Test. b. Job Plan Sheet.

BEST COPY AVAILABLE

SELF-CHECK FOR ENABLING OBJECTIVE 2 number PAGE 12 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your work by answering the items below. All items should receive a "YES" response.

1. Were safety glasses worn?
2. Was rod turned in steps for faster filing?
3. Was rod fed from chuck for each step?
4. Was rod heated until it was red in color?
5. Was rod quenched in water?
6. Was rod drawn to dark straw?
7. Was rod draw bent to blue?

If you received a "NO" response for any item, go back and repeat one or more of the Learning Activities for this Enabling Objective.

PERFORMANCE TEST FOR C | 1 | 3

duty task number

PAGE 13 OF 15

DIRECTIONS:

Given access to a file, file cord, vise, and lathe, you will practice filing. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were safety glasses worn?..............................		
2. Was rod turned in steps for faster filing?..............		
3. Was rod fed from chuck for each step?...................		
4. Was rod heated until it was red in color?...............		
5. Was rod quenched in water?..............................		
6. Was rod drawn to dark straw?............................		
7. Was rod draw bent to blue?..............................		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained
☐ Not attained

EVALUATOR

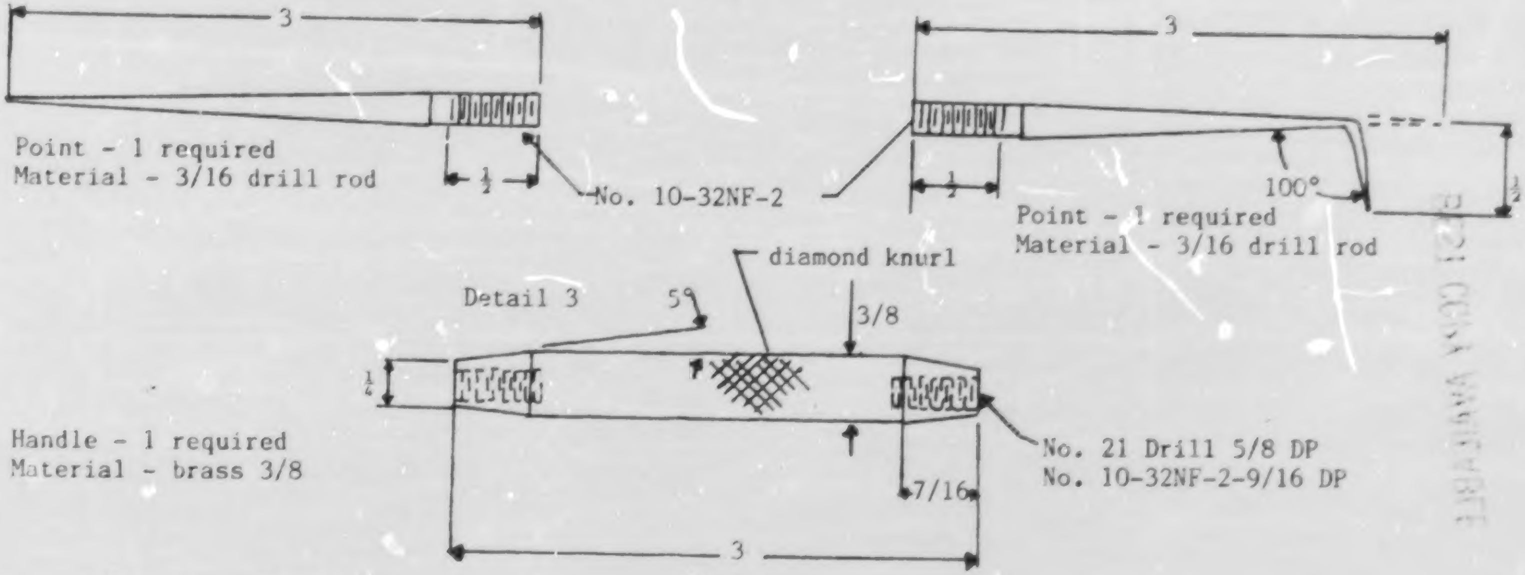
DEPT.

PROG.

DUTY	TASK	EN OBJ.	DEPT	PROG

Detail 1

Detail 2


3
½
No. 10-32NF-2
3
½
100°
½
diamond knurl
5°
3/8
¼
7/16
3

Point - 1 required
Material - 3/16 drill rod

Point - 1 required
Material - 3/16 drill rod

Detail 3

Handle - 1 required
Material - brass 3/8

No. 21 Drill 5/8 DP
No. 10-32NF-2-9/16 DP

Instructional Resources

Texts

Krar, S., Oswald J. W., and St. Amand, J., Machine Tool Operations Visutext McGraw-Hill Publishing Co., New York, 1983.

KNOWLEDGE TEST FOR C 1 3

duty task number

PAGE 1 OF 2

DUTY

TASK

DEPT.

PROG.

TASK Practice Filing

DIRECTIONS: Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. Which tool is made for cleaning files?

    a. brush card
    b. bench brush
    c. file card
    d. emery cloth

2. To prevent scratches on pieces held in a vise, cover the jaws with

    a. a rag.
    b. cardboard.
    c. sheet steel.
    d. sheet cooper.

3. To prevent chips from clogging the teeth of a file, what can be applied to its face?

    a. chalk
    b. oil
    c. water
    d. powder

4. Work is held in a vise

    a. to hold it solid.
    b. to eliminate work chatter.
    c. to position the stock at the proper height.
    d. all of the above

5. Which direction does the file cut?

    a. in both directions
    b. on the forward stroke
    c. on the back stroke

KNOWLEDGE TEST FOR C | 1 | 3

CONTINUED duty task number

PAGE 2 OF 2

DUTY

TASK

DEPT.

PROG.

6. For precision filing the tip of the file is held with the thumb

   a. on the top and the fingers wrapped around the tip.
   b. on top and the fingers wrapped around the file.
   c. and index finger.
   d. and fingers stretched far apart.

7. Draw filing is used to

   a. remove stock quickly.
   b. produce a smooth finish.
   c. use the full length of the file.
   d. remove burrs.

8. What speed is the lathe run for filing on work?

   a. 1/2 of cutting speed
   b. 1/2 more than cutting speed
   c. the same as cutting speed
   d. a very low speed

9. Broken file teeth are caused by

   a. not cleaning the file.
   b. filing too fast.
   c. too light a pressure.
   d. too heavy a pressure.

10. A file should never be used without

    a. formal training.
    b. a file cleaner.
    c. a handle on the tang.
    d. the work held in a vise.

STUDENT LEARNING GUIDE

# THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

PROGRAM: MACHINE SHOP

DUTY: C COMPLETING CORE CURRICULUM

TASK: 2 0 Use Vertical Band Saw

PURPOSE:

When a student has gained enough experience with a hand hacksaw, he may be allowed to use a vertical band saw. Most teachers restrict the use of the band saw blade. You should learn how to operate a band saw properly because it can save time and may keep you from injuring yourself.

PLEASE DO NOT WRITE IN LEARNING GUIDE

DUTY
TASK
PREREQ.
DEPT.
PROG.
REVISED

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

DUTY	TASK	DEPT.	PROG.

PERFORMANCE OBJECTIVE:
(include condition, performance, and standard)

GIVEN: access to a vertical band saw and blade,

YOU WILL: use vertical band saw.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the steps in installing a band saw blade.
2. Practice using a vertical band saw.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1

number

PAGE 4 OF 24

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

Enabling objective

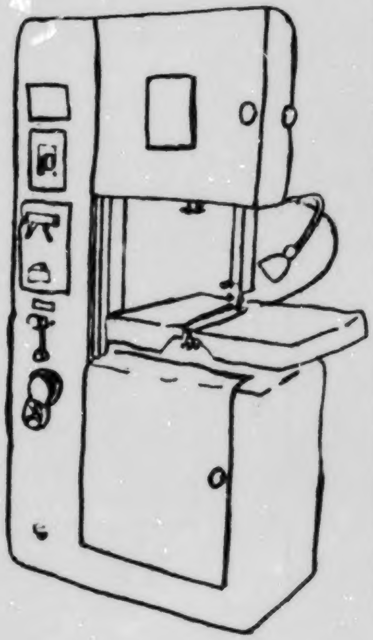
Identify the steps in installing a band saw blade.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1 to identify the steps in installing a band saw.	1. Instruction Sheet enclosed, Installing a Band Saw Blade
2. Complete the Self-Check.	2. Self-Check enclosed.
3. Practice installing a vertical band saw blade. Complete the Self-Check. Have your instructor check your work.	3. a. Band saw b. Blades c. Self-Check enclosed.
4. When you think you can attain this task take the Knowledge Test.	4. Knowledge Test.
5. Go on to Enabling Objective No. 2.	

Installing a Band Saw Blade

Advantages of the Vertical Band Saw



1. MAINTAINS SHARPNESS: Each tooth on a band saw blade is a precision cutting tool and the load is spread over many teeth. Chip load is spread over many teeth. Chip load is uniform and constant on each tooth, minimizing tool wear.

2. UNRESTRICTED CUTTING: Cutting can be done at any angle, in any direction, and the length of the cut is unlimited.

3. HOLDS ITS OWN WORK: Cutting action is downward so the cutting forces hold the work to the table.

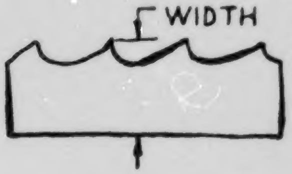
4. LITTLE WASTE: The band saw cuts directly to shape; unwanted material is removed in solid sections.

Blade Selection

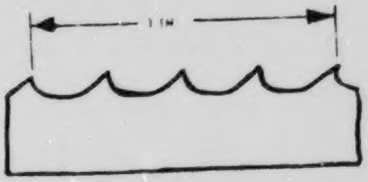
Some blade manufacturers list more than 500 different band saw blades. Points which must be considered by the machinist when selecting the proper blade for a specific job are:

1. BLADE TYPE. There are six basic types of band saw blades.
    a. Tungsten carbide
    b. Bimetal (high speed cutting edge with flexible steel back)
    c. High-speed steel
    d. Shock resistant
    e. Hard edge with spring tapered back
    f. Carbon steel flexible back

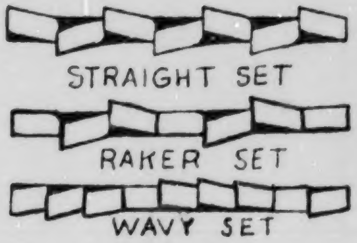
Blade Characteristics



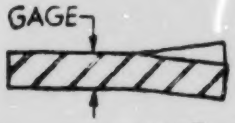
a. Width The wider the blade the greater its strength and the more accurate it will cut. Use the widest blade the machine will accommodate when making straight cuts.
Contour cutting should utilize the widest blade that will cut the required radii. Widths from 1/16 to 2" are available.



b. Pitch Pitch refers to the number of teeth per inch of blade. The thickness of the material to be cut determines the pitch. At least three teeth should be in contact with the work for best performance. Pitches from 2 to 32 per inch are manufactured.



c. Set Set provides clearance for the blade back. Raker set is recommended for cutting large solids or thick plate and bar stock. Wavy set should be used for work with varying thicknesses such as pipe, tubing, and structural materials. Straight set is specified for free cutting material like aluminum and magnesium.

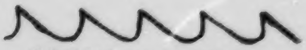


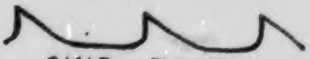
d. Gage Gage refers to the thickness of the blade. Extra strength can be obtained when using narrow blades by securing a blade of a heavier gage.

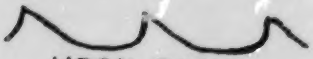
e. Tooth Form Tooth form is the shape of the tooth. There are three basic forms. Each has its specific applications.

1. Standard tooth blade with well rounded gullets are usually best for most ferrous materials, hard bronze, and brass.
2. Skip tooth blade provide for more gullet and better chip clearance without weakening the blade body. They are recommended for most aluminum, magnesium, and brass.
3. Hook tooth blades offer two advantages over the skip tooth blade: the blade design makes it feed easier and its chip breaker design prevents gumming up.

. There are three


STANDARD TOOTH


SKIP TOOTH


HOOK TOOTH

DUTY

TASK

EN. OBJ.

DEPT.

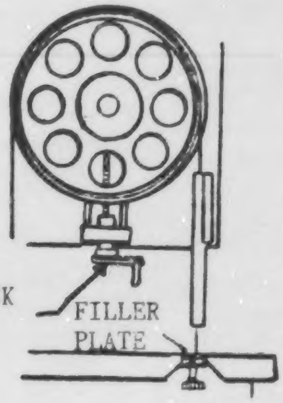
PROG.

Installing a Blade

The blade on a band saw tracks on two large wheels. The pressure exerted against the blade is absorbed by guides. One set of guards is located on the arc above the work and the other under the table.

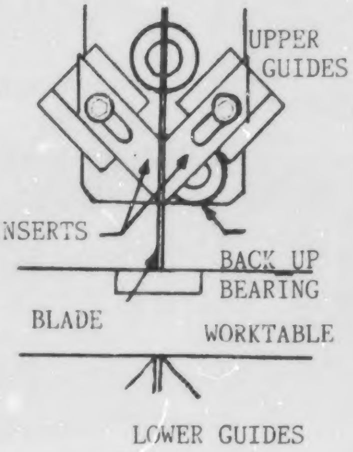
Step 1. Remove the old blade.

- a. Open doors covering wheels.
- b. Remove the filler plate from the table.
- c. Release tension by lowering the upper wheel with the tension crank.
- d. Pull the blade out.



Step 2. Install a new blade.

- a. Install new blade on wheels, increase tension (IMPORTANT: TEETH MUST BE POINTED DOWNWARD).
- b. Inspect guides if the new blade is the same as the old one; the guides should not need any adjustment. If the blade is different the guide may need adjustment for width and clearance.

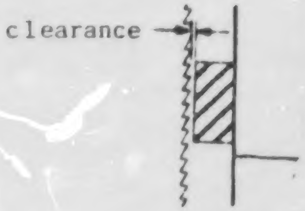


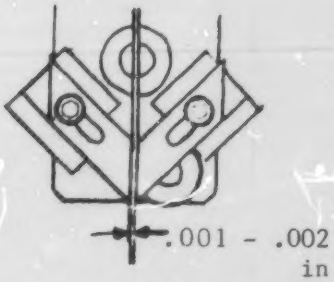
Width -- Guides are made in sets for different widths of blade. A guide marked 1/2" blade; a guide too thick would ruin the set of the blade. A guide tooth in would allow the blade to twist the work.

Clearance -- Keeps the blade from binding in the guides. There should be .001 to .002 clearance between the guide and the blades.

Step 3. Tracking

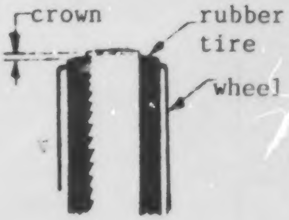
a. Set the gearshift lever in the neutral position.
b. Rotate the upper wheel by hand; the blade should be tracking directly over the center of the wheel. If not, turn the knob behind the wheel while rotating the wheel.
c. There should be no noticeable gap between the back of the band and the back-up bearings of the upper and lower saw guides.

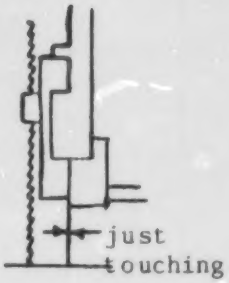




Step 4. Tension

a. The degree of tension is determined by the width and pitch of the blade. Use the band tension chart furnished with the machine.
b. Many band machines have build-in tension meters; adjust the tension to that indicated on the chart.
c. (New blades have a tendency to stretch so readjust after using the blade for a while).





Step 5. Testing

a. Replace the filler plate in the table.
b. Re-engage the gearshift lever. If it does not engage, rotate the upper wheel a little.
c. Close the doors on the upper and lower carrier housing.
d. Start the machine and quickly shut it off again. Observe the blades as they pass through the guides for any misadjustments.

BEST COPY AVAILABLE

SELF-CHECK FOR ENABLING OBJECTIVE 1 number

PAGE 10 OF 24

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. What are the advantages of a band saw over other cutting machines?
2. One of the characteristics of a band saw blade is its width. What effect does blade width have on the cut?
3. What is pitch and how does it affect cutting?
4. What is set in saw teeth and how does it affect cutting?
5. What are the types of set and when is each used?
6. Which tooth form is designed for cutting ferrous metals and which is designed for non-ferrous metals?
7. What is the function of band saw guides?
8. What is the procedure for installing a band saw blade?
9. What is the procedure for preparing to cut something on a band saw?
10. Where will the band saw welder be found?
11. The band saw welder works on what type of welding principal?
12. How is the saw blade cut to the proper length?
13. What is the procedure for preparing the ends of the blade?
14. How is the blade placed in the welder?
15. What safety equipment should be worn while welding blades?
16. What is the procedure for welding the blade after it is positioned?

17. What are some defects the weld should be inspected for?

18. After the blade has been welded and inspected, what preparation must the weld have before the blade can be used?

Now check your answers with the Answer Key.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number
ANSWER KEY

PAGE 12 OF 24

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

1. -more cutting teeth
-unrestricted cutting-angle, length, or direction
-downward cutting action holds the work to the table
-cuts directly to shape

2. The wider the blade the greater its strength and the more accurate it will cut.

3. Pitch refers to the number of teeth per inch. The larger the teeth on the blade, the less of a chance that they will load up. If the teeth are too large they will catch on the work so try to have at least three teeth cutting at all times.

4. The teeth on a saw blade are off-set so that the cut they make is wider than the blade. This keeps it from binding up. The set of teeth also allows the blade to cut an arc. The radius of the arc is determined by the width of the blade.

5. Raker set-used to cut large pieces of solid stock or plate.
Wavy set-used to cut aluminum and magnesium.

6. Standard tooth-for most ferrous materials.
skip tooth-for most nonferrous materials.

7. Guides support the blade to keep it from twisting when the direction of cutting is changed.

8. -remove the old blade
-put the new blade on the wheels with the teeth pointing down
-check the guide to see if they are the correct ones and are installed properly
-put some tension on the blade. Rotate the wheel and get the blade to track properly. Adjust the tension to the proper setting.

9. -check to see that the blade is the right one for the job and that it is in good condition
-lower the upper saw guide until it is 1/4" above the work
-start the machine and set it at the proper speed

10. The band saw welder is located on the column of the band saw itself.

11. The band saw welder is a resistance type welder. Heat is generated by the flow of electricity through it.

12. The blade is cut to length in the cut off shear which is located on or next to the welder.

13. Loop the cut length of the blade and bring the two ends together with the teeth pointing in opposite directions. Grind both ends together on the flash grinding unit of the welder. Grind off the teeth in the area which will be consumed during the welding process.

14. The blade is pos[illegible]ned so it is against the aligning surface on the back of th[illegible]aws and the joint is centered between the two jaws. The two ends must be butting against each other for the full width.

15. Safety glasses.

16. Set the weld selector switch for the width of the blade being welded.
Depress the welding lever and hold it until the weld has cooled. Release one movable jaw clamp, then release the welding lever.

17. Overlapped weld, incomplete weld, excess metal, misaligned weld, burned out weld.

18. Anneal the blade in the welder using the proper techniques. Grind off welding flash on the flash grinding unit. Grind until weld area passes through thickness gauge. Temper the blade to a blue color.

All of your answers should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number
CONTINUED

PAGE 14 OF 24

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

11. Was the filler plate replaced in the table? ______ ______

12. Was the gearshift lever reengaged? ______ ______

13. Were the doors closed on the upper and lower carrier housing? ______ ______

14. Was the machine quickly started and shut-off? ______ ______

If you received a "NO" response for any item go back and repeat one or more of the Learning Activities for this Enabling Objective.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number PAGE 15 OF 24

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your work by answering the items below. All items should receive a "YES" response.

	YES	NO
1. Was blade selected according to		
a. width?	____	____
b. pitch?	____	____
c. set?	____	____
d. gage?	____	____
e. tooth form?	____	____
2. Was old blade removed by opening the doors covering the wheels?	____	____
3. Was the filler plate removed from the table?	____	____
4. Was the tension released by lowering the upper wheel with the tension crank?	____	____
5. Was the blade pulled out?	____	____
6. Were teeth pointed downward to install new blades?	____	____
7. Were guides inspected and adjusted if necessary?	____	____
8. Was the gearshift lever set in the neutral position?	____	____
9. Was the upper wheel rotated by hand (the blade should be tracking directly over the center of the wheel)?	____	____
10. Was the degree of tension determined by the width and pitch of the blade?	____	____

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE

☐ number

PAGE 16 OF 24

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective

Practice using a vertical band saw.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1 to identify the procedure for cutting with a vertical band saw.	1. Instruction Sheet enclosed, Cutting Procedure
2. Complete the Self-Check. Have your instructor check your work.	2. Self-Check enclosed.
3. When you think you can perform this task take the Performance Test.	3. Perform Test.

Cutting Procedure

1. Determine the proper blade to use for the job. Consideration must be given to the materials, thickness, type of cut (straight or curved), and the finish desired.

2. Mount the proper saw blade and guides on the machine.

3. Place the work in the table and lower the upper saw guide until it clears the work by 1/4".

4. Start the machine and see that the band is tracking properly.

5. Consult the job selector chart and set the proper speed. Shifting gears between low and high gear must be done with the motor off. Changing the speed of the machine must be done with the motor on. IT IS VERY IMPORTANT THAT YOU GET THE CORRECT CUTTING SPEED. TOO MUCH SPEED WILL BURN UP THE TEETH.

6. Place the material against the workholding jaw or against a block of wood.

7. Carefully bring the workpiece up to the blade and start the cut. NOTE: When the workpiece is to be finished by some other machining operation, the cut should be made about 1/32 inch outside the layout line.

8. Carefully feed the workpiece into the saw. Do not use too much pressure. Keep the fingers clear of the moving blade.

9. When the cut is complete, do not leave the saw while it is still running. Clean the table with a bench brush, not your hands.

Band Saw Welding

Welders on vertical band saws are RESISTANCE TYPE welders which fuse the ends of the blade together when the correct current is applied and the blade is held properly. Improper welds will cause the blade to break, and it will require rewelding. Unless the weld is as strong as the band itself, it is not a good weld.

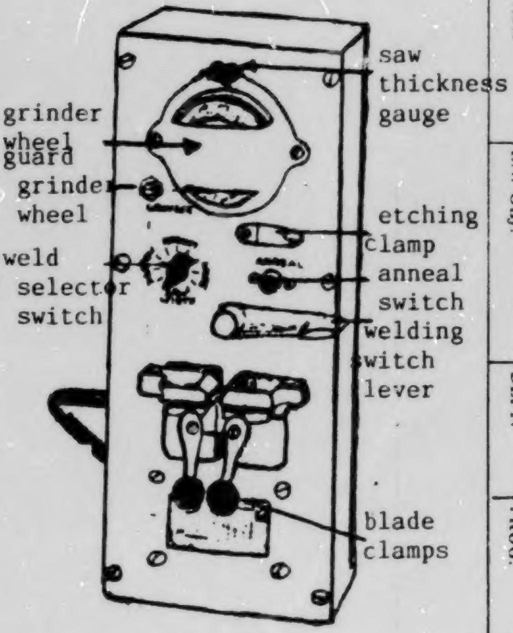

saw thickness gauge
grinder wheel guard
grinder wheel
etching clamp
weld selector switch
anneal switch
welding switch lever
blade clamps

Figure 1

To Weld a Band Saw Blade

1. Select the proper blade for the job.
2. Determine the length of blade required. (The blade length for a two wheel machine is determined by adding twice the center to center distance of the wheels plus the circumference of one wheel. If the upper wheel is extended the full distance, deduct 1" to allow for the stretch of the blade.)
3. Place the blade in the cut-off shear, and cut it to the required length. Make sure that the blade is held straight and up against the blade squaring bar on the shear. Figure 2.

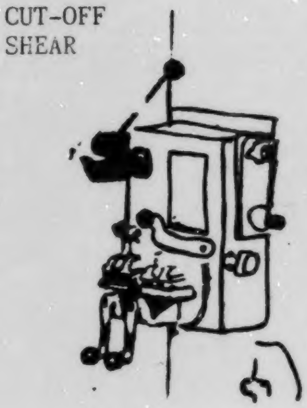

CUT-OFF SHEAR

Figure 2

4. If the ends of the blade are not square, hold them firmly, as in figure 3 and grind both ends flat in one operation. If the ends are not square at this time, it will not matter since when the blade ends are placed together for welding, the ends will match perfectly.

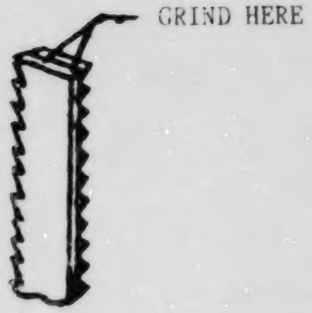


Figure 3.

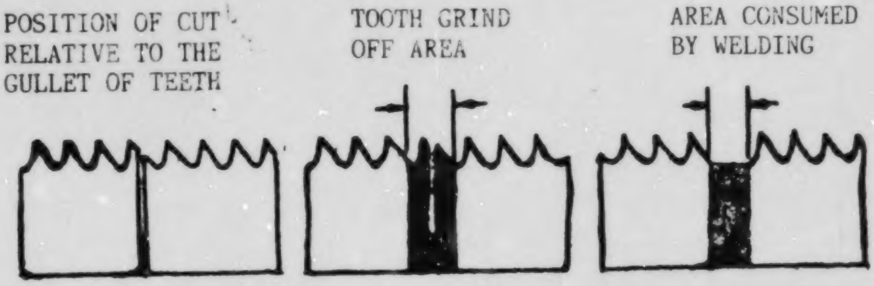
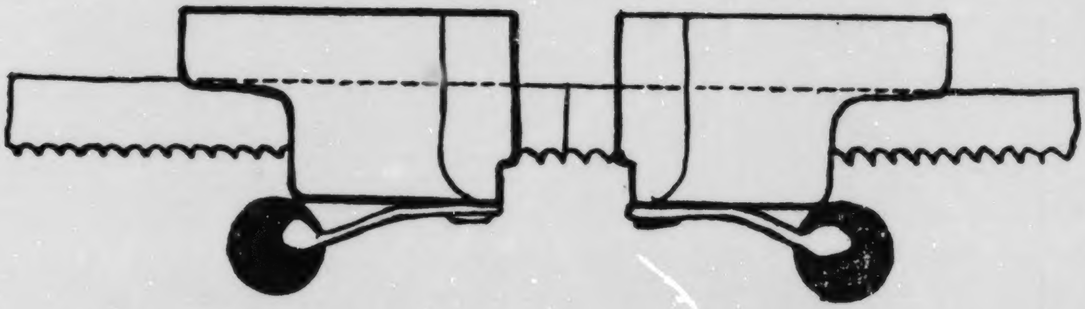


Figure 4.

5. In order to get the proper tooth spacing after the blade has been welded, it is necessary to grind off some tooth at the ends of the blade to the depth of the gullet prior to welding. This is necessary since the welding operation consumes some of the blade length. The number of teeth that are ground off will depend on the pitch of the blade. Figure 4.

6. Adjust the WELD SELECTOR SWITCH for the width of the blade being welded.

7. Clamp the blade as shown in figure 5. Make sure that the blade is against the aligning surface on the back of the jaws and centered between the two jaws. If the ends of the blades do not butt against each other for the full width, they should be removed and reground.



8. Stand to one side and wear safety glasses to avoid injury from the welding flash. Depress the welding switch or lever and hold it until the weld is cooled. (Figure 6)

9. Release one movable jaw clamp and then release the welding lever. Doing this operation in reverse may fracture the weld.

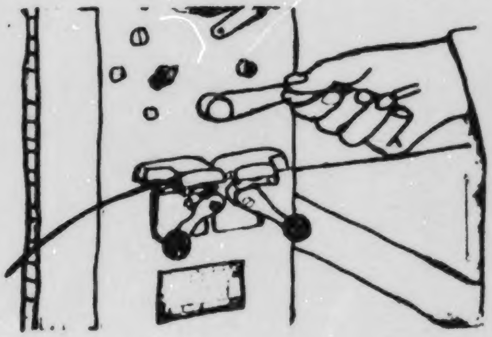
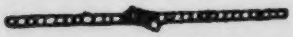


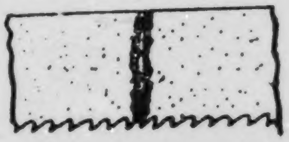
Figure 6

10. Remove the blade and check the weld for the following points:
    1. The flash material must be uniform on both sides.
    2. The spacing of the teeth should be uniform.
    3. The weld should be in the center of the gullet.
    4. The back of the blade should be straight. (Figure 7)

    If the blade does not meet all of these requirements, it should be broken, prepared again, and rewelded.

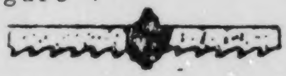


Overlapped weld



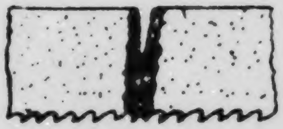
Incomplete weld

Figure 7



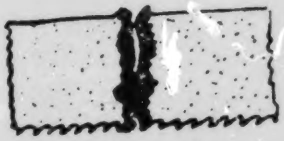
11. Reclamp the blade, with the weld in the center of the jaws and the teeth to the rear.

12. Push in the ANNEAL SWITCH BUTTON and jog it intermittently until the band reaches a DULL RED color. CAUTION: Do not permit the blade to become too hot or it will air harden as it cools. To avoid this, press in the anneal switch button from time to time to slow down the cooling process.



Misaligned weld

13. Remove the blade and grind off the welding flash. Grind the weld to the same thickness as the blade, being careful not to grind the teeth.



"Burned Out" weld

Continually check the thickness of the blade in the THICKNESS GAUGE located on the welder. When properly ground, it should just glide through the thickness gauge. (figure 8)

14. After the blade has been ground to the proper thickness, it is advisable to anneal the blade to a blue color.

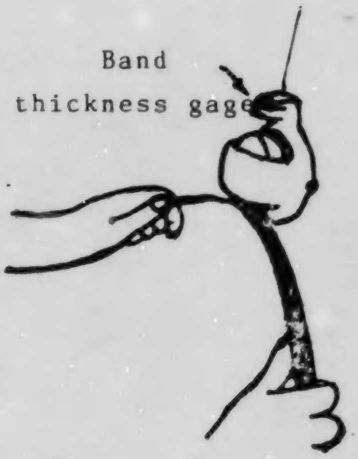


Figure 8

PERFORMANCE TEST FOR C | 2 | 0

duty — task number

PAGE 22 OF 24

DIRECTIONS:

Given access to a vertical band saw and stock, you will use vertical band saw. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were safety glasses worn?......		
2. Was the blade installed according to the procedure listed on the Instruction Sheet?......		
3. Was the work placed in the table and the upper saw guide lowered until it cleared the work by 1/4"?......		
4. Was the machine started to be sure it was tracking?......		
5. Was the speed set using the job selector chart?......		
6. Was the material placed against the work holding jaw or against a block of wood?......		
7. Was the workpiece brought up to the blade and the cut started?......		
8. Was the workpiece fed into the saw, keeping the fingers clear of the moving blade?......		
9. Was the saw turned off when the cut was complete?......		
10. Were two pieces of stock cut 2" x 5" x 1/2"?......		
11. Was the table cleaned with a brush?......		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained
☐ Not attained

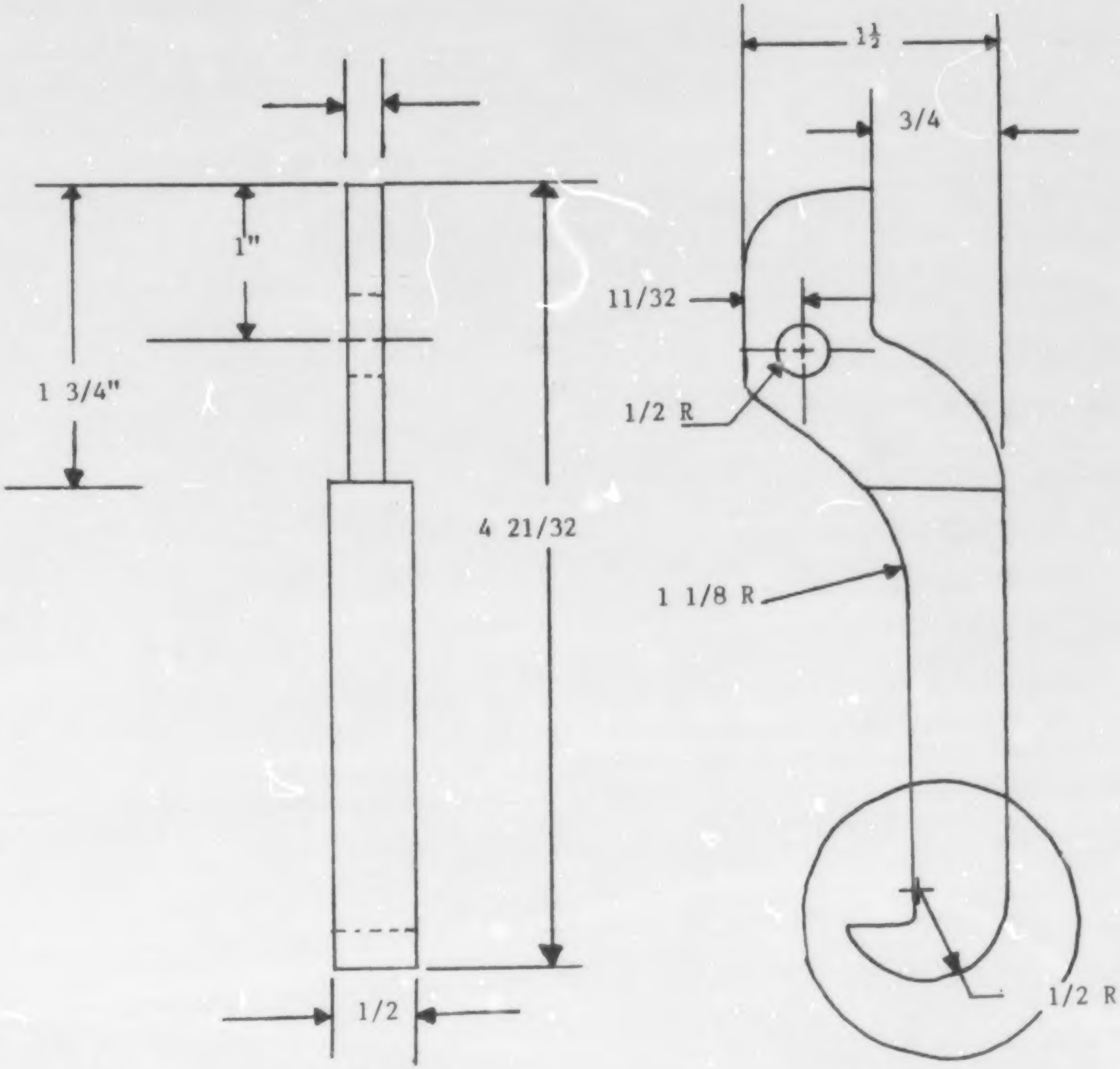
EVALUATOR

DEPT.

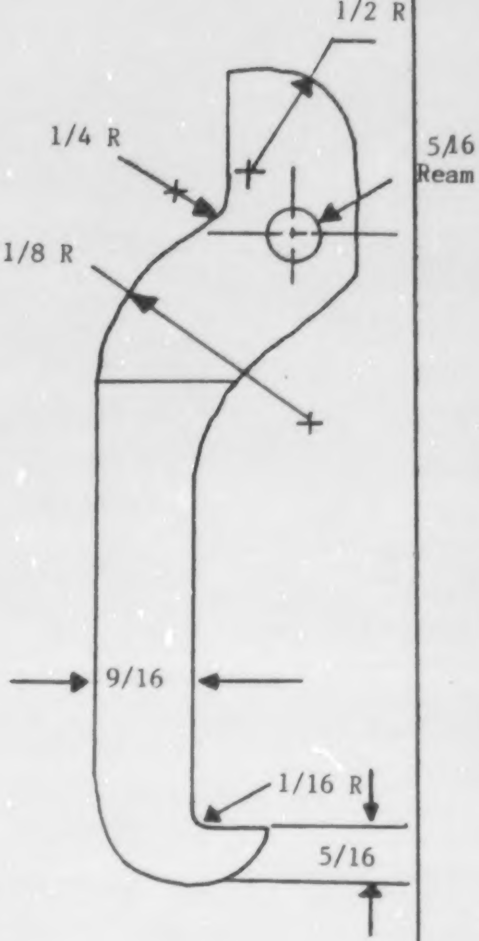
PROG.

DUTY	TASK	EN. OBJ.	DEPT.	PROG.

PAGE 23 OF 24


1"
1 3/4"
4 21/32
1/2
$1\frac{1}{2}$
3/4
11/32
1/2 R
1 1/8 R
1/2 R

42


1/2 R
1/4 R
5/16 Ream
1/8 R
9/16
1/16 R
5/16

43

JOB PLAN SHEET

DUTY
TASK
DEPT.
PROG.

Instructional Resources

No additional resources required.

KNOWLEDGE TEST FOR C 2 0

duty task number

PAGE 1 OF 3

DUTY

TASK

DEPT.

PROG.

TASK: Use Vertical Band Saw

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. In order to keep the blades from binding, the guides must have the proper
   a. clearance and width.
   b. angle and width.
   c. tension and clearance.
   d. angle and clearance.

2. Which of the following is not a type of set found on band saw blades?
   a. Wavy.
   b. Offset.
   c. Straight.
   d. Raker.

3. The speed of the machine is changed
   a. with the motor running.
   b. while the machine is coasting.
   c. with the motor off.

4. Changing from high to low range is done with the machine
   a. on.
   b. coasting.
   c. unplugged.
   d. off.

5. The pitch of the blade refers to the
   a. shape of the tooth.
   b. number of teeth per inch.
   c. clearance for the blade back.
   d. thickness of the blade.

6. When sawing, the top guides should be located ______ inch above the work.
   a. 1.
   b. 1/4
   c. 1/2
   d. 3/4

7. The set of a blade refers to
   a. number of teeth per inch.
   b. clearance for the blade back.
   c. shape of the tooth.
   d. thickness of the blade.

8. After using the band saw, the table is cleaned off with
   a. compressed air.
   b. a piece of scrap.
   c. your hand.
   d. a bench brush.

9. The best tooth form for cutting aluminum is
   a. hook.
   b. standard.
   c. wavy.
   d. raker.

10. The degree of tension on a blade is determined by the pitch and ________ of the blade.
    a. set
    b. width
    c. tooth form
    d. gage

11. Which of the following is not a characteristic of cutting with a band saw?
    a. unrestricted cutting
    b. work must be held in something
    c. cutting teeth last longer
    d. little waste material

12. To determine the proper blades to use for a job you must consider the material, type of cut, finish desired, and
    a. length.
    b. size.
    c. hardness.
    d. thickness.

13. The bands' location on the wheels is refered to as
    a. following.
    b. tracking.
    c. alignment.
    d. tension.

14. Whenever possible the stock being sawed should be pushed with
    a. a stick.
    b. a C-clamp.
    c. hands.
    d. workholding jaw.

BEST COPY AVAILABLE

KNOWLEDGE TEST FOR C | 2 | 0

CONTINUED duty task number PAGE 3 OF 3

DUTY

TASK

DEPT.

PROG.

15. If the blade is positioned in the welder and nothing happens when the welding switch is depressed, a possible cause is
    a. the blade is slipping.
    b. there are oxides between the joint.
    c. the ends of the blade are not touching.
    d. all of the aove.

16. After welding the blade
    a. release one movable jaw clamp and then release the welding lever.
    b. release the welding lever then the movable jaw clamps.

17. When annealing the blade, prevent the weld from cooling too quickly by
    a. covering it with your hand.
    b. pressing the anneal switch button from time to time.
    c. holding the button down until the weld has cooled.
    d. putting the blade in a closed area.

BEST COPY AVAILABLE

STUDENT LEARNING GUIDE

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

PROGRAM: MACHINE SHOP

DUTY: C COMPLETING CORE CURRICULUM

TASK: 2 8 Operate Bridgeport J-Head

PURPOSE:

Machine tools are operated most efficiently by someone who understands the function of their controls. In this learning guide, we will look at a machine found in many machine shops and manufacturing plants across the the U.S.A.

DUTY

TASK

PREREQ.

DEPT.

PROG.

REVISED

PLEASE DO NOT WRITE IN LEARNING GUIDE

BEST COPY AVAILABLE

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

DUTY	TASK	DEPT.	PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance,
and standard)

GIVEN: access to a Bridgeport machine,

YOU WILL: operate Bridgeport J-Head.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the parts of the Bridgeport J-Head.
2. Operate a Bridgeport J-Head.

BEST COPY AVAILABLE

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1

number

PAGE 4 OF 18

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective

Identify the parts of the Bridgeport J-Head.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. View Resource No. 1 to identify the parts of the Bridgeport J-Head.	1. Instruction Sheet enclosed, Parts of the Bridgeport J-Head.
2. Read Resource No. 2 to identify the function of each part of the Bridgeport J-Head.	2. Instruction Sheet enclosed, How the Bridgeport J-Head Operates
3. Complete the Self-Check.	3. Self-Check enclosed.
4. When you think you can attain this task take the Knowledge Test.	4. Knowledge Test.
5. Go on to Enabling Objective No. 2.	

INSTRUCTION SHEET FOR ENABLING OBJECTIVE 1 number PAGE 5 OF 18

DUTY

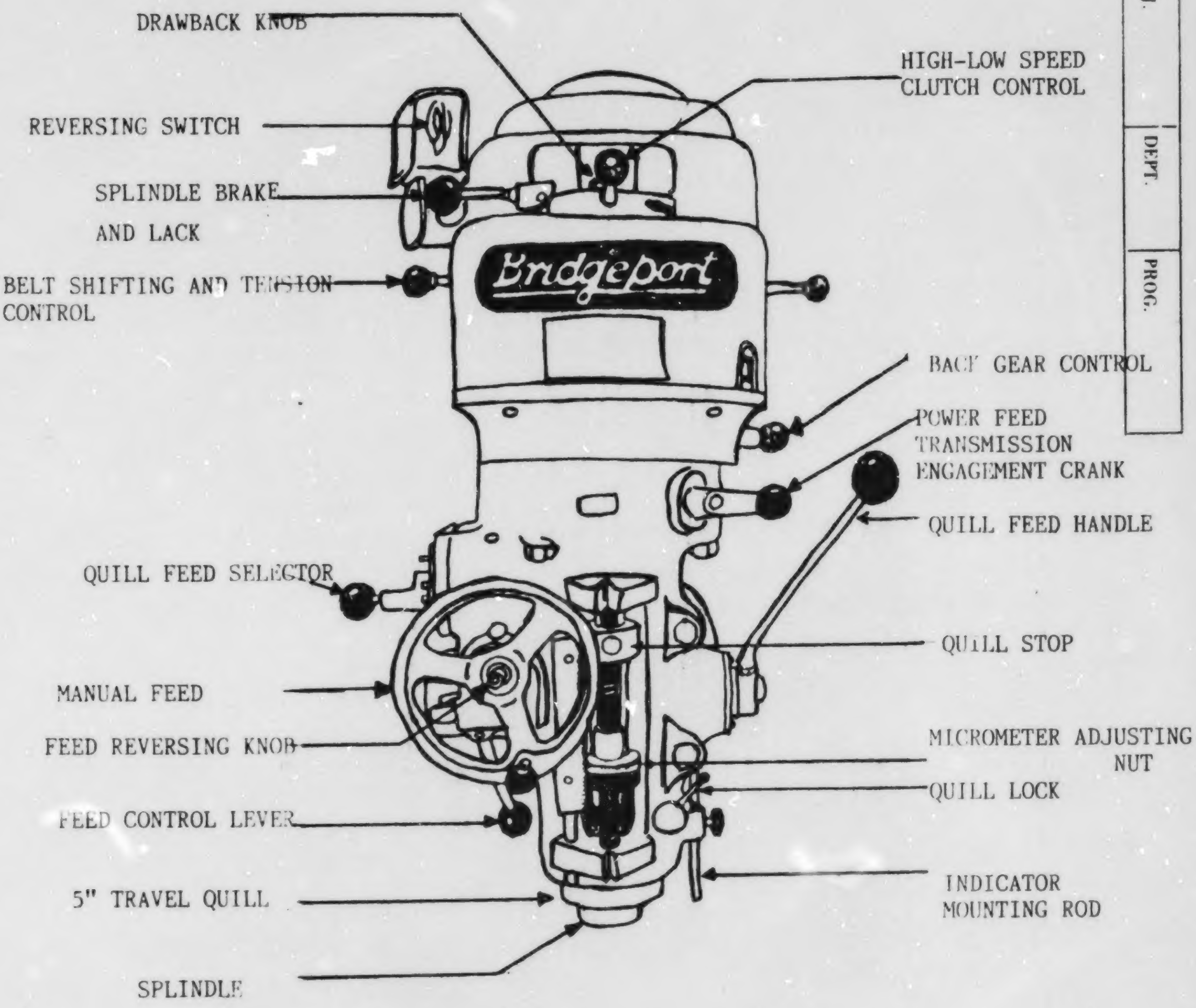
TASK

EN. OBJ.

DEPT.

PROG.

Parts of the Bridgeport J-Head


DRAWBACK KNOB
HIGH-LOW SPEED CLUTCH CONTROL
REVERSING SWITCH
SPLINDLE BRAKE AND LACK
BELT SHIFTING AND TENSION CONTROL
Bridgeport
BACK GEAR CONTROL
POWER FEED TRANSMISSION ENGAGEMENT CRANK
QUILL FEED HANDLE
QUILL FEED SELECTOR
QUILL STOP
MANUAL FEED
FEED REVERSING KNOB
MICROMETER ADJUSTING NUT
QUILL LOCK
FEED CONTROL LEVER
INDICATOR MOUNTING ROD
5" TRAVEL QUILL
SPLINDLE

BRIDGEPORT J-HEAD. Figure 1

BEST COPY AVAILABLE

How the Bridgeport J-Head Operates

Many machining operations are performed on vertical milling machines. This package will explain the control levers of a Bridgeport H-Head and how to operate these.

Drawbar

The function of the drawbar is to pull the tool or collet holding the tool into the tapered portion of the spindle nose. The drawbar has a right hand thread. When tightening or loosening the drawbar, it is necessary to lock the spindle. To remove a tool from a collet, loosen the drawbar 1 turn counterclockwise. If this does not release the tool, give the knob on top of the drawbar a slight tap with a soft-head hammer which usually releases the tool.

Spindle Brake

The spindle brake lever can be moved in either direction to stop the spindle. To lock the spindle move the lever to the right or left until firm resistance is felt and then raise it. The spindle brake lever will stay in this position.

CAUTION: Always be certain that the spindle brake lever is released to its neutral, center position before starting the motor. The motor will be damaged if it is turned on without unlocking the brake.

Reversing Switch

This switch is used to change the directional rotation of the spindle. Forward is clockwise rotation of the spindle when high speed is used. Forward will give counterclockwise rotation of the spindle when the low range or back gear of the machine is in use.

High Low Speed Clutch Control

When the lever is in the straight forward position, as shown in the illustration, the clutch is in the high speed position. To change to low speed, turn the lever all the way to the right. Rotate the spindle while engaging the high speed clutch. This can be accomplished by turning the spindle nose by hand or with a wrench on the drawbar.

CAUTION: DO NOT shift clutch while motor is running. The back gear control lever is used with the high low speed clutch. Above the back gear control lever is stamped IN and OUT. The back gear control lever is in the OUT position when the high-low speed clutch is in high, with the controls in these positions high range (660-2720 RPM) is used. When a change to the low RPM range (80-325) is needed, move the back gear control lever to IN and the high-low speed clutch lever to the extreme right.

CAUTION: When changing from low to high range, turn the spindle by hand until a firm click indicates that the gears are in mesh.

CAUTION: DO NOT force any control lever. All controls should engage easily. If difficulties arise, consult your instructor.

Power Feed Transmission Engagement Crank

This crank engages a power feed worm. The power feed worm is engaged when the crank is pointing to the back of the head as in the illustration. To disengage the worm gear, pull knob out and turn handle in a clockwise direction to the opposite position. To engage the worm, a counterclockwise movement is required.

CAUTION: The power feed worm may be engaged while the spindle is rotating, however, it should be engaged gently to avoid damage to the worm gear. The worm gear may be disengaged any time. Disengage the power feed worm gear when power feed is not required. This will avoid unnecessary wear on the power feed worm.

Quill Feed Selector

This crank is used when selecting any of the three powerfeeds. The feeds available are .0015", .003" and .006" per revolution of the spindle. The feeds are marked on the coverplate below each indentation hole. The feed is more easily engaged while the spindle is turning.

Feed Reversing Knob

The position of this knob depends on the direction of rotation of the spindle. Down feed, with the spindle rotating clockwise, is obtained by pulling the feed reverse knob out until the clutch becomes engaged. Pushing the knob in, past the neutral center position will make it possible to feed up. The feed reversing knob should be left in neutral unless in use.

Feed Control Lever

The lever engages the power feed when pulled to the left. Power feed will stay engaged until the quill stop comes against the micrometer nut or against the safety pin on top which will disengage it - or the feed control lever is disengaged manually. The feed control lever is equipped with a pre-set overload clutch. When a pre-set pressure is exerted on the micrometer nut, or the top quill stop, the feed control lever is automatically disengaged.

Manual Feed

To use the handwheel for raising and lowering the quill, the reversing clutch knob should be in the neutral position and the feed control lever engaged. Clockwise rotation of the hand-feed control lever engaged. Clockwise rotation of the handwheel will move the quill down. The handwheel may be disengaged by moving it about 1/8" outward from the machine.

Quill Feed Handle

This handle may be removed by pulling it off the shaft. Disengage the handle when using power feed.

Quill Stop

The quill stop is used to disengage the automatic feed in either direction.

Micrometer Adjusting Nut

The nut is graduated in .001 increments. The nut in combination with the scale mounted next to it can be used as a precision depth stop.

Quill Lock

The quill lock is used to lock the quill from moving in or out of the head. The quill should be locked in an UP position while milling unless it has to be extended out from the head for longer reach.

Indicator Mounting Rod

The indicator mounting rod is used to hold an indicator for set-up work.

Lubrication

Before operating the machine lubricate the head. You will find two oil cups located on the right side of the belt housing. Use a few drops of light machine oil.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number PAGE 10 OF 18

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. What are the two functions of the spindle brake?
2. When the machine is in low range and the reversing switch is in forward, in what direction does the spindle rotate?
3. How is the collet loosened from the spindle?
4. What is the most important point to remember when shifting the high-low speed clutch control?
5. Is the power feed worm gear usually engaged?
6. What position should the feed reverse knob be in when not in use?
7. Can you shift from the low to the high speed range while the motor is running?
8. Is the quill feed handle always engaged?
9. How accurately can the depth stop be controlled?
10. When does the manual feed handwheel activate the quill?
11. What are the feeds available in automatic feed?
12. When is the quill locked?
13. What is the purpose of the quill stop?
14. How often should the workhead be lubricated?
15. How many lubrication points are on a J-Head?
16. When should the quill feed selector be engaged?

Now check your answers with the Answer Key.

SELF-CHECK FOR ENABLING OBJECTIVE 1 ANSWER KEY

number

PAGE 11 OF 18

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

1. One function is to stop the spindle after turning the motor off. The other is to lock the spindle while changing tools.

2. In low range, the spindle will rotate counterclockwise when the switch is in forward.

3. Lock the spindle, then turn the drawbar one turn counterclockwise. Should the collet still be tight, tap the drawbar lightly with a soft-head hammer.

4. When shifting from low to high, you will have to turn the spindle by hand until a loud click tells you that the clutch is engaged. If you don't do this, when you turn the motor on, you may strip the teeth from the clutch.

5. No, only when powerfeed is used. This prevents undue wear.

6. Neutral

7. No, do not make any speed changes while the motor is running.

8. No, it should be disengaged when power feed is used.

9. Adjustments can be made in .001" increments.

10. When the reversing clutch knob is in neutral and the feed control lever engaged.

11. .0015", .003", and .006".

12. Whenever the quill doesn't move in or out of the wheel head; especially while milling.

13. The quill stop will disengage the automatic feed at either the micrometer adjusting nut or the top of the quill travel. The quill stop will contact the pre-set depth stop.

14. Before using.

15. Two, on the right side of the wheelhead.

16. While the machine is running.

All of your answers should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2 number

PAGE 12 OF 18

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective

Operate a Bridgeport J-Head.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1 practice operating a Bridgeport J-Head.	1. Bridgeport J-Head.
2. Complete the Self-Check. Have your instructor check your work.	2. Self-Check enclosed.
3. When you think you can perform this task take the Performance Test.	3. a. Performance Test b. Job Plan Sheet

SELF-CHECK FOR ENABLING OBJECTIVE 2 number

PAGE 13 OF 18

DUTY

TASK

EN. OBJ.

DEPT.

PROC.

DIRECTIONS:

Evaluate your knowledge by answering the items below. All items should receive a "YES" response.

	YES	NO
1. Were safety glasses worn?		
2. Was power hacksaw used to cut 1 piece 3 3/8" in length?		
3. Was workpiece set in four jaw chuck (with one end faced in lathe just to clean it)?		
4. Was a 6" combination square-scriber layout dye used to scribe a line on all four sides 3" from finished end?		
5. Was workpiece placed back in four jaw chuck and faced off to layout line?		
6. Was the position of the 3/8" laid out?		
7. Was hole tapped?		
8. Was workpiece prick punched?		
9. Was workpiece center drilled using 16-tap drill per the chart?		
10. Was hole tapped through using 3/8 - 16 tap with workpiece held in vise with soft jaws?		
11. Was the 6" combination-scriber layout dye used to layout the angles on the right hand end?		

BEST COPY AVAILABLE

SELF-CHECK FOR ENABLING OBJECTIVE 2 number

CONTINUED

PAGE 14 OF 18

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

12. Was workpiece set in shaper or milling machine? _____ _____

13. Was workpiece cut to lines? _____ _____

14. Were chamfers laid out on the 4 corners on the opposite end? _____ _____

15. Was workpiece filed to these lines? _____ _____

16. Was workpiece polished using 180 grit emery cloth? _____ _____

17. Were all sharp corners broken off? _____ _____

18. Was workpiece repolished and reassembled by hand? _____ _____

If you received a "NO" response for any item go back and repeat one or more of the Learning Activities for this Enabling Objective.

PERFORMANCE TEST FOR C | 2 8

duty task number

PAGE 15 OF 18

DIRECTIONS:

Given access to a Bridgeport milling machine with a J-Head you will operate the machine. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were safety glasses worn?............		
2. Was power hacksaw used to cut 1 piece 3 3/8" in length?............		
3. Was workpiece set in four jaw chuck (with one end faced in lathe just to clean it)?............		
4. Was a 6" combination square-scriber layout dye used to scribe a line on all four sides 3" from finished end?............		
5. Was workpiece placed back in four jaw chuck and faced off to layout line?............		
6. Was the position of the 3/8" laid out?............		
7. Was hole tapped?............		
8. Was workpiece prick punched?............		
9. Was workpiece center drilled using 16-tap drill per the chart?............		
10. Was hole tapped through using 3/8 - 16 tap with workpiece held in vise with soft jaws?............		
11. Was the 6" combination-scriber layout dye used to layout the angles on the right hand end?............		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained

☐ Not attained

EVALUATOR

DEPT.

PROG.

PERFORMANCE TEST FOR C | 2 8

CONTINUED duty task number

PAGE 16 OF 18

PERFORMANCE STANDARDS

ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
12. Was workpiece set in shaper or milling machine?		
13. Was workpiece cut to lines?		
14. Were chamfers laid out on the 4 corners on the oposite end?		
15. Was workpiece filed to these lines?		
16. Was workpiece polished using 180 grit emery cloth?		
17. Were all sharp corners broken off?		
18. Was workpiece repolished and reassembled by hand?		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained

☐ Not attained

EVALUATOR

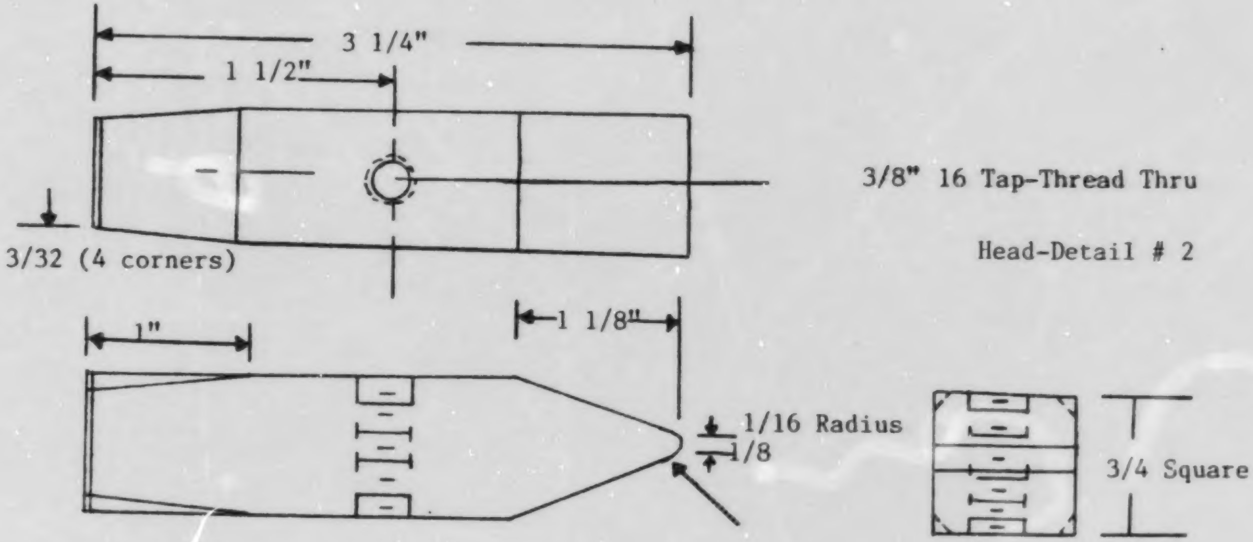
DEPT.

PROG.

JOB PLAN SHEET

PAGE 17 OF 18

DUTY	TASK	EN. OBJ.	DEPT.	PROG.


3 1/4"
1 1/2"
3/8" 16 Tap-Thread Thru
3/32 (4 corners)
1"
1 1/8"
1/16 Radius
1/8
3/4 Square

Head-Detail # 2

Instructional Resources

No additional resources required.

KNOWLEDGE TEST FOR C 2 8
duty task number

PAGE 1 OF 3

DUTY
TASK
DEPT.
PROG.

TASK: Operate Bridgeport J-Head

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. The spindle brake is used
   a. while changing collets.
   b. to get slow speeds.
   c. to keep a preload on the motor.
   d. when a preset depth is reached.

2. The quill lock is used
   a. while milling slots.
   b. to stop the quill from moving out of the head.
   c. to hold the cutter at a preset depth.
   d. all of the above.

3. The feed control lever
   a. controls the feed direction.
   b. determines the amount of feed.
   d. in used to engage power feed.
   d. all of the above.

4. The quill stop
   a. is used as a depth stop.
   b. is used to lock the quill.
   c. is a spindle brake.
   d. all of the above.

5. The high-low speed clutch
   a. can be engaged while the motor is running.
   b. cannot be engaged while the motor is running.
   c. is controlled by the back gear lever.
   d. is magnetically controlled.

6. To move the quill with the handwheel the
   a. feed control lever has to be engaged.
   b. quill feed selector has to be in manual.
   c. quill stop is disengaged.
   d. spindle has to revolve slowly.

KNOWLEDGE TEST FOR C 2 8

CONTINUED duty task number PAGE 2 OF 3

DUTY

TASK

DEPT.

PROG.

7. The micrometer adjusting nut is
   a. accurate to .0001".
   b. fixed to the quill.
   c. a precision depth stop.
   d. not used when power feed is on.

BEST COPY AVAILABLE

KNOWLEDGE TEST FOR C | 2 8

CONTINUED duty task number

PAGE 3 OF 3

DUTY

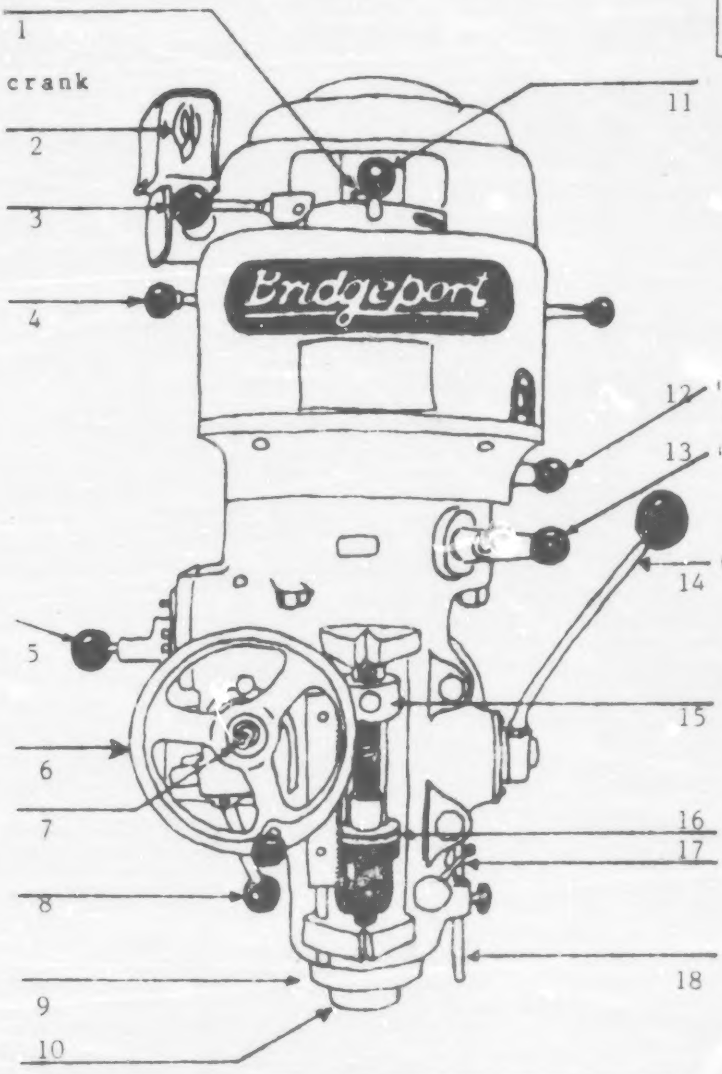
TASK

DEPT.

PROG.

Evaluate your knowledge by matching the correct letter to the number.

a. quill lock
b. quill feed selector
c. manual feed handwheel
d. quill stop
e. high-low speed clutch
f. backgear control
g. quill
h. feed reversing switch
i. spindle
j. micrometer adjusting nut
k. reversing switch
l. spindle brake
m. feed control lever
n. drawbar knob
o. quill feed handle
p. power feed engagement crank



STUDENT LEARNING GUIDE

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

PROGRAM: MACHINE SHOP

DUTY: 2 PERFORMING DRILL OPERATIONS

TASK: 0 9 Perform Hand Grinding

PURPOSE:

The bench or pedestal grinder is a machine that is found in all metal shops and many home work-shops. It is a necessity for sharpening cutting tools such as drills, chisels, punches, and tool bits, besides being useful for general metal removal. Everyone who works with grinders should also know how to use one safely because grinding wheels can cause injury.

PLEASE DO NOT WRITE IN LEARNING GUIDE

DUTY
TASK
PREREQ.
DEPT.
PROG.
REVISED

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

OBJECTIVES

DUTY

TASK

DEPT.

PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance, and standard)

GIVEN: access to pedestal grinder, star dresser, carborundum stone and dresser,

YOU WILL: perform hand grinding.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the steps in performing hand grinding.
2. Practice performing hand grinding.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1 number

PAGE 4 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective

Identify the steps in performing hand grinding.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No.1 to identify the steps in preparing to grind.	1. Instruction Sheet enclosed, Preparing to Grind
2. Read Resource No. 2 to identify the steps in preparing to grind.	2. a. Text: Machine Tool Operations Visutext, page 114. b. Instruction Sheet enclosed, Some Basic Grinding Operations
3. Complete the Self-Check.	3. Self-Check enclosed.
4. When you think you can attain this task take the Knowledge Test.	4. Knowledge Test.
5. Go on to Enabling Objective No. 2.	

Preparing to Grind

Setting the Tool Rest

A tool rest is provided to support the work while grinding. As the grinding wheel wears down or after it has been dressed, the spacing between the wheel and the tool rest will be too great. It is recommended that the rest be adjusted to a minimum of 1/16 inch and a maximum of 1/8 inch from the wheel.

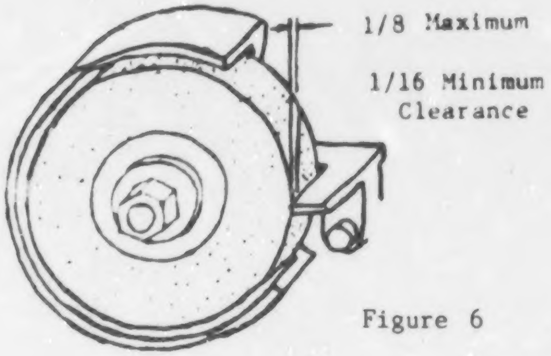
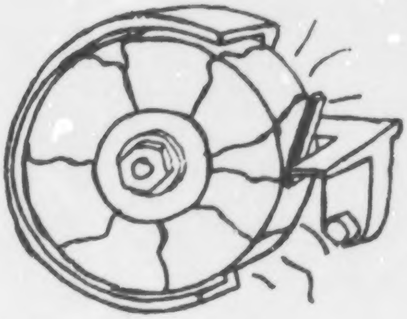


Figure 6



TOO MUCH SPACING

Besides adjusting the tool rest for clearance it must also be adjusted to the proper height. The rest must be set on the horizontal center line of the wheel, if it is lower than this, the wheel will tend to draw the workpiece down between the wheel and the rest.

To adjust the tool rest, loosen the bolt that holds the rest secure to the frame. Figure 7. The wheel should not be rotating when this is done. Move the rest inward until the proper clearance is obtained, then tighten the bolts. If the rest is not centered horizontally loosen the bolt and adjust while maintaining the proper clearance. Figure 8. Turn the wheel by hand to be sure there is sufficient clearance. See figures 7 and 8 on the next page.

Dressing and Truing a Grinding Wheel

As a grinding wheel is used, the sharp abrasive grains get broken down and the pores of the wheel become clogged with ground particles that form a glaze.
The edges of the wheel get rounded off and the face of the wheel may get a groove in it. The face of the wheel can be resurfaced by cleaning it with a wheel dresser. Figure 11.

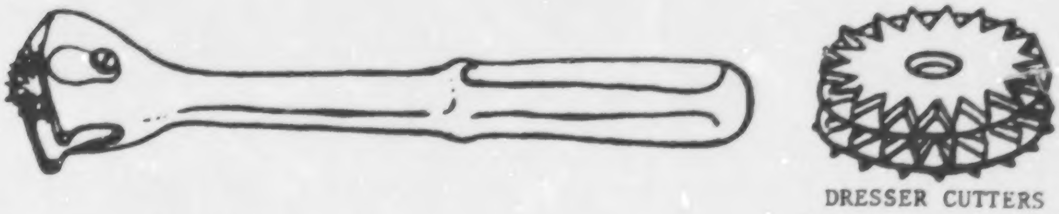
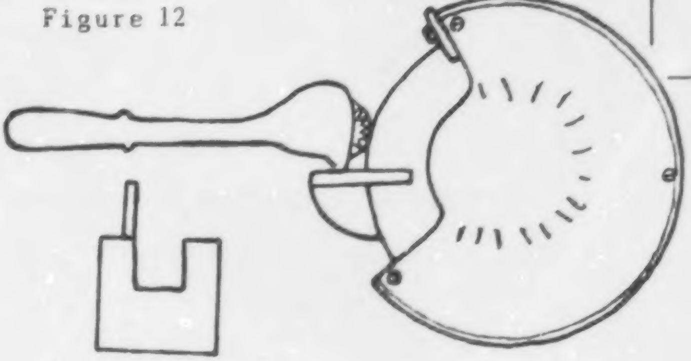


Figure 11

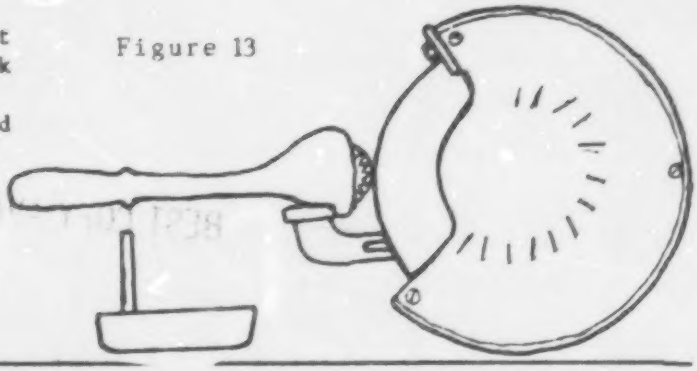
When dressing a wheel with the wheel enveloping type of tool rest, Figure 12, hold the handle firmly with both hands and resting the two prongs of the dresser on the tool rest. If sparks are being formed, that means that the teeth of the cutters are being ground off. To prevent this, press harder against the face of the wheel. There should be no sparks. Don't allow the dresser to move in and out as the wheel rotates because it will make the wheel out of round.

Figure 12



When dressing a wheel with the straight type of tool rest. Figure 13, use the same procedures except that the tool rest is moved back so that the prongs of the wheel dresser can be hooked over it. This method results in a truer surface on the wheel.

Figure 13



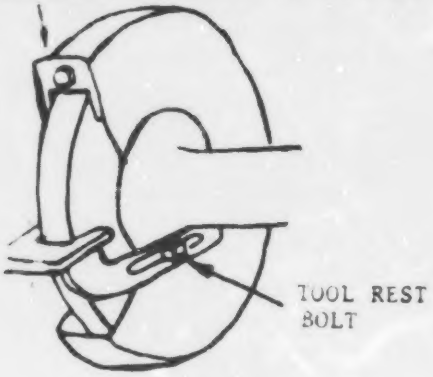

TOOL REST
BOLT

Figure 7

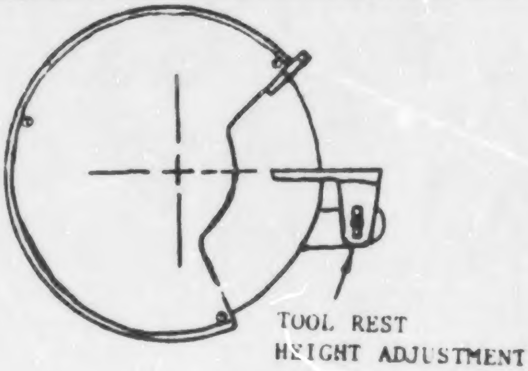

TOOL REST
HEIGHT ADJUSTMENT

Figure 8

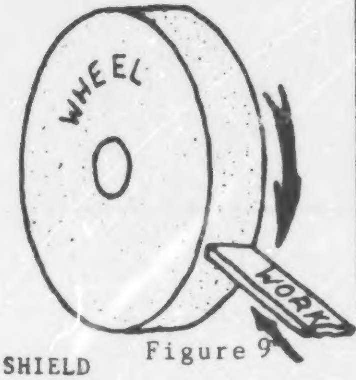


Figure 9

NOTE: Whenever the wheel is dressed, the WHEEL GUARD CAP must be adjusted as well as the tool rest. (Figure 7).

Grinding

Grinding is the operation that removes metal by rotating an abrasive wheel against the work. Figure 9.

Bench and Pedestal Grinder

The bench and pedestal grinder usually has a grinding wheel on each end of a shaft which extends through an electric motor. This grinder is used for general grinding and for sharpening some simple tools. The grinding done on this type of grinder is called OFFHAND GRINDING, that is, work which does not require great accuracy. Figure 10

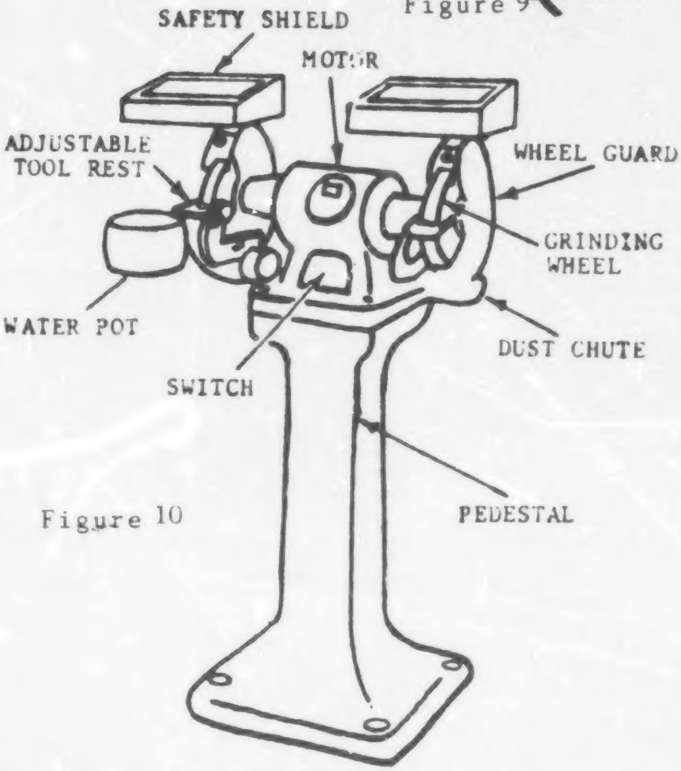

SAFETY SHIELD
MOTOR
ADJUSTABLE TOOL REST
WHEEL GUARD
GRINDING WHEEL
WATER POT
DUST CHUTE
SWITCH
PEDESTAL

Figure 10

INSTRUCTION SHEET FOR ENABLING OBJECTIVE 1 number PAGE 8 OF 16

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

Some Basic Procedures for Grinding

Offhand grinding can only be as accurate as the person doing the grinding. In order for a beginner to do a good job and work safely, he should keep these points in mind:

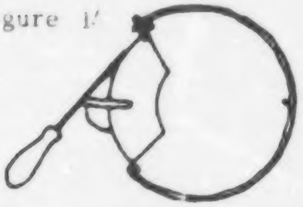
1. Be sure the glass eye shields are in place. They are made with tempered glass and will withstand the impact of an exploding wheel. Safety glasses or a face shield should be worn.
2. Check the tool rest to see if it has the proper spacing from the wheel.
3. Do not attempt to use a grinder unless the wheel guards are in place and securely fastened.
4. It is considered good practice to stand to one side of the machine when it is first turned on and until it reaches operating speed.
5. Dress the face of the wheel if it is glazed or is clogged with foreign materials.
6. When grinding, use only the face of the wheel, never the side. Hold the workpiece firmly on the rest.
7. Move the work back and forth across the face of the wheel so that you do not make a groove in the wheel.
8. Cool the work frequently in the water pot. With a cutting tool you must be careful not to over heat it and draw the temper.
9. Never force the work against the grinding wheel. A sudden shock may cause the wheel to explode. To much pressure will overload the motor, causing it to heat up.
10. Grind only metals that are composed of iron (ferrous). Any other metals (non-ferrous) are too soft and will clog the pores of the grinding wheel.

Some Basic Grinding Operations

Sharpening a Screwdriver

The screwdriver used for slotted screws should have a flat, blunt point with tapered sides. Grind either side of the point a little at a time, hollow grinding it on the upper part of the wheel. Figure 14. Then hold the screwdriver flat on the tool rest and grind the end. Figure 15.

Figure 14



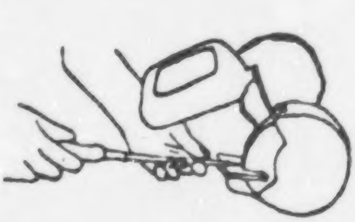
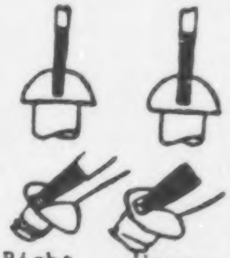


Figure 15



Sharpening a Cold Chisel

The right hand holds the shank of the chisel, keeping the proper angle on the cutting edge and guides the cutting edge back and forth slowly and gently across the face of the wheel. The left hand keeps the chisel against the tool rest by holding it with the thumb and forefinger. Figure 16.

If the chisel point begins to turn colors, it is getting too hot and is drawing the temper. Keep the chisel cool by dipping it in water often. Examine the chisel often to make sure that the same amount is ground off both sides and that the cutting edge is correct. Figure 17. If the chisel is too pointed, drop the point of the chisel down on the wheel while grinding. If it is too blunt, raise the point on the wheel.

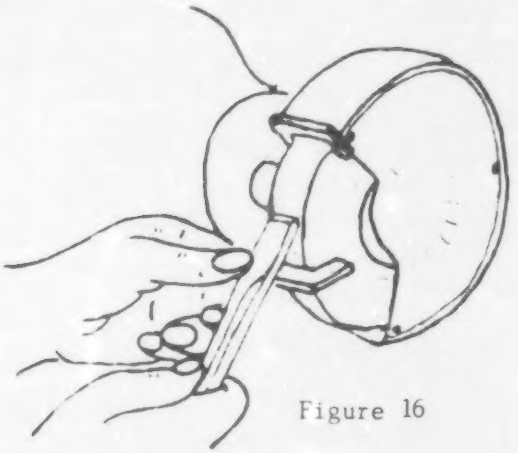


Figure 16

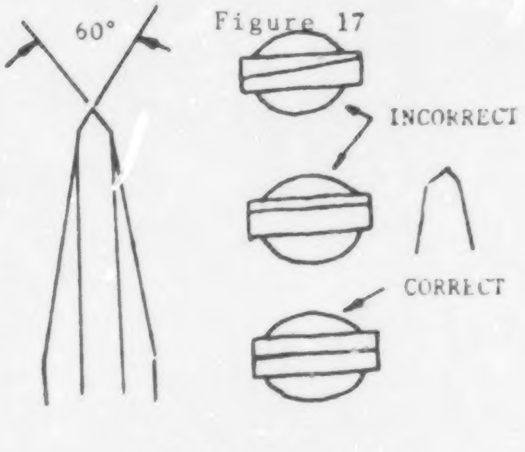


Figure 17

Sharpening a Center or Prick Punch

To sharpen a prick punch or a center punch, rest it on the tool rest and bring the point against the face of the wheel at the correct angle. Figure 18. Rotate the punch with the fingers. Grind until the point is sharp and located in the center of the punch. Figure 19.

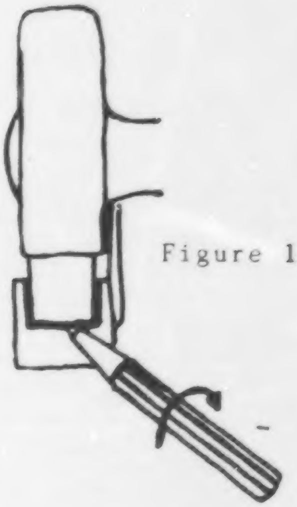


Figure 18

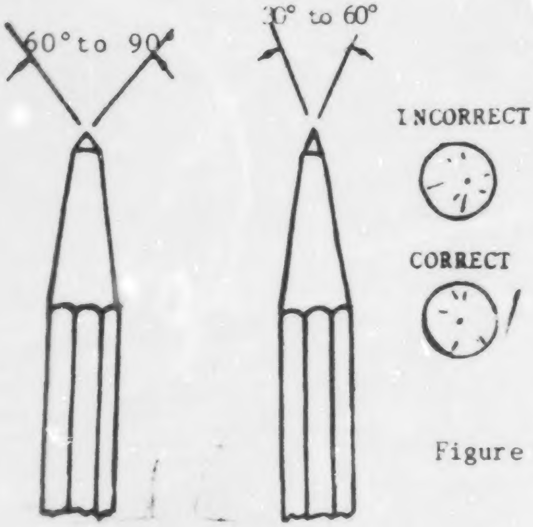


Figure 19

SELF-CHECK FOR ENABLING OBJECTIVE 1 number PAGE 11 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. Why is the grinding wheel incased in a wheel cover?
2. What part of the grinder is designed to support the work being ground?
3. What is OFFHAND grinding?
4. Why must a grinding wheel be resurfaced?
5. What is the procedure of resurfacing a wheel called?
6. What is the procedure for setting the tool rest?
7. What safety equipment should be worn while grinding?
8. On what area of the wheel should grinding be done?
9. What types of metal can be ground on the grinder and what type cannot?
10. When sharpening a cold chisel or a screwdriver the point is pointed in what direction? Why?
11. Why must you not allow the point of the cold chisel to turn blue while it is being ground?

Now check your answers with the Answer Key.

BEST COPY AVAILABLE

SELF-CHECK FOR ENABLING OBJECTIVE 1 number

ANSWER KEY

PAGE 12 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

1. Grinding wheels can explode while the grinder is running. This can be caused by striking the wheel or by getting something caught between the wheel and the tool rest

2. The tool rest.

3. OFFHAND grinding is grinding done on an object which does not require great accuracy. Examples would be: sharpening a cutting tool or grinding a weld down smooth.

4. When a grinding wheel gets a glaze or groove on its face and the corners get rounded off, its' face must be resurfaced.

5. Resurfacing a wheel is done with a wheel dresser. The prongs of the dresser are rested on or hooked over the tool rest, depending on the type of rest. The cutters are brought into contact with the face of the wheel with firm pressure. As the cutters are moved across the wheel its' face is trued and resurfaced. If sparks are coming off the cutters, more inward pressure must be exerted.

6. The tool rest must be positioned so there is a maximum of 1/8 inch between it and the wheel face. The top of the rest must be in line with the horizontal center of the wheel. Adjust the rest in by loosening the bolt holding the rest to the wheel guard housing. Some rests have a bolt which allows a height adjustment. Adjustments are made with the wheels stopped. Checking for wheel clearance is done by rotating the wheel by hand.

7. Safety glasses or a face shield.

8. On the face of the wheel.

9. Only grind metals which are composed of iron. All other metals (non-ferrous) are soft and will clog the pores of the wheel.

10. Chisels and screwdrivers are sharpened with the point UP so there is no chance of welding the point between the wheel and the rest.

11. If the point of the chisel gets too hot it will draw or lose the temper (make it softer) of the metal. You can prevent this by dunking the chisel in water periodically.

All of your answers should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2

number

PAGE 13 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective:

Practice performing hand grinding.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1 practice hand grinding.	1. a. Pedestal grinder a. Star dresser
2. Complete the Self-Check. Have your instructor check your work.	2. Self-Check enclosed.
3. When you think you can perform this task take the Performance Test.	3. Performance Test.

BEST COPY AVAILABLE

SELF-CHECK FOR ENABLING OBJECTIVE 2 number PAGE 14 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your work by answering the items below. All items should receive a "YES" response.

	YES	NO
1. Were safety glasses worn?		
2. Was the pedestal grinder tool rest set to the specified clearance?		
3. Was the grinding wheel visually checked for damage?		
4. Was the grinding wheel dressed with a star dresser?		
5. Was the grinding wheel dressed with a carborundum stone?		

If you received a "NO" response for any item, go back and repeat one or more of the Learning Activities for this Enabling Objective.

BEST COPY

PERFORMANCE TEST FOR 2 | 0 9

duty task number

PAGE 15 OF 16

DIRECTIONS:

Given access to a pedestal grinder, star dresser, and carborundum stone, you will perform hand grinding. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were safety glasses worn?...............................		
2. Was the pedestal grinder tool rest set to the specified clearance?...............................		
3. Was the grinding wheel visually checked for damage?...............................		
4. Was the grinding wheel dressed with a star dresser?...............................		
5. Was the grinding wheel dressed with a carborundum stone?...............................		

BEST COPY AVAILABLE

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained

☐ Not attained

EVALUATOR

DEPT.

PROG.

DUTY

TASK

DEPT.

PROG.

Instructional Resources

Texts

Krar, S., Oswald J. W., and St. Amand, Joseph, Machine Tool Operations Visutext, McGraw-Hill Publishing Co. New York, 1983.

KNOWLEDGE TEST FOR 2 (duty) 0 9 (task number)

PAGE 1 **OF** 3

TASK: Perform Hand Grinding

DIRECTIONS:
Evaluate your knowledge by answering the items below using a separate sheet of paper.

DUTY

TASK

DEPT.

PROG.

1. The grinding wheel rotates __________ the tool rest.
   a. away from
   b. toward

2. You should adjust the tool rest with the motor
   a. coasting.
   b. on.
   c. stopped.

3. The tool rest should have a maximum clearance of
   a. 1/8".
   b. 1/10".
   c. 1/4".
   d. 3/32".

4. You can grind ______ metals on a grinder.
   a. only ferrous
   b. alloy
   c. all
   d. only non-ferrous

5. A cutting tool should be cooled as it is ground to prevent
   a. damaging the wheel.
   b. burning yourself.
   c. melting the metal.
   d. drawing the temper.

6. Grinding should be done on the
   a. face and side of the wheel.
   b. face of the wheel.
   c. spot on the wheel.

DUTY

TASK

DEPT.

PROG.

7. While grinding you should always wear
   a. gloves.
   b. safety glasses.
   c. a shop coat.
   d. shoes.

8. The name for grinding on a pedestal grinder is
   a. circular grinding.
   b. rough grinding.
   c. offhand grinding.
   d. free grinding.

9. The tool rest should be set so that it is in line with
   a. the horizontal axis.
   b. the vertical axis of the grinding wheel.
   c. and slightly above the center of the grinding wheel.
   d. none of the above.

10. When the face of a wheel is resurfaced, the device used is a wheel
   a. conditioner.
   b. dresser.
   c. resurfacer.
   d. smoother.

Evaluate your knowledge by answering True or False to the items below using a separate Answer Sheet.

1. Forcing the work against the wheel may cause it to explode.
2. The grinding wheel is made of an abrasive material.
3. A chisel and a screwdriver would be sharpened with the point down.
4. The work should be supported by the tool rest.
5. It is all right to stand in front of the grinder when it is turned on.
6. Any metal can be ground on a grinding wheel.

STUDENT LEARNING GUIDE

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

PROGRAM: MACHINE SHOP

DUTY: 2 PERFORMING DRILL OPERATIONS

TASK: 0 4 Perform Counterboring, Countersinking, and Spotfacing

PURPOSE:

It is often necessary to make a seat for a flat head screw or a socket head bolt. When a hole is drilled on a rough and uneven surface, a spot facing operation must be performed so the bolt head will have a machined seat. This learning guide will familiarize you with these operations.

PLEASE DO NOT WRITE IN LEARNING GUIDE

DUTY
TASK
PREREQ.
DEPT.
PROG.
REVISED

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

OBJECTIVES

PAGE 3 OF 15

DUTY

TASK

DEPT.

PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance, and standard)

GIVEN: access to a drill press,

YOU WILL: perform counterboring, countersinking, and spotfacing.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the steps in countersinking, and counterboring and spotfacing.
2. Practice countersinking, counterboring and spotfacing.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE

1
number

PAGE 4 OF 15

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

Enabling objective

Identify the steps in countersinking, counterboring, and spotfacing.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1 identifying the steps in countersinking, counterboring and spotfacing.	1. Instruction Sheet enclosed, Countersinking Counterboring and Spotfacing
2. View Resource No. 2.	2. Bergwall filmstrip and cassette "Countersinking and Counterboring".
3. Complete the Self-Check.	3. Self-Check enclosed.
4. When you think you can attain this task take the Knowledge Test.	4. Knowledge Test.
5. Go on to Enabling Objective No. 2.	

INSTRUCTION SHEET FOR ENABLING OBJECTIVE 1 number PAGE 5 OF 15

DUTY

TASK

EN. OBJ.

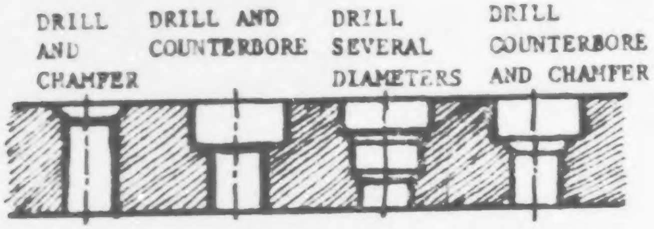
DEPT.

PROG.

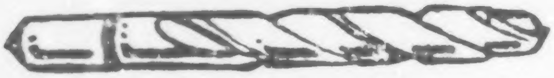
Countersinking, Counterboring, Spotfacing

Counterbores

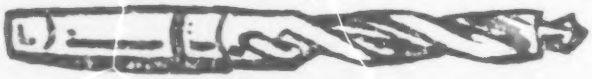
Counterbores are used to enlarge previously drilled holes. They are also used for spotfacing. A dual cut drill can be used to drill the hole and spotface or counterbore in the same operation. See figure 1.


DRILL AND CHAMFER
DRILL AND COUNTERBORE
DRILL SEVERAL DIAMETERS
DRILL COUNTERBORE AND CHAMFER

TYPES OF HOLES PRODUCED BY COMBINATION DRILLS



COMBINATION DRILL



DUAL CUT DRILL

Figure 1

Counterbores need a guide or pilot which positions it in the hole. They are available in the interchangeable type, (see figure 2); also with a fixed pilot, head, and shank in one piece.

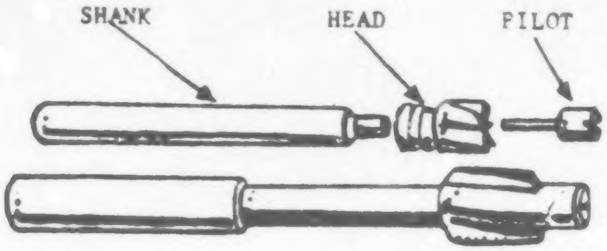
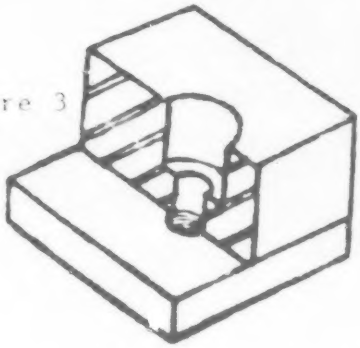


Figure 2 A straight shank interchangeable counterbore.

The pilots are made for standard bolt sizes. The drilled hole for the pilot must not be too tight so the pilot will bind, but is should not be more than .005" over the size of the pilot or breakage may occur. The heads are made slightly larger than the heads of socket head bolts. See figure 3.

Figure 3



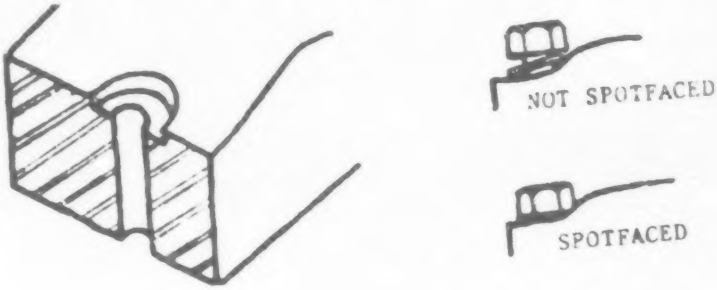


Figure 4

Figure 3-A sectional view of a hole that has been drilled and counterbored to receive a socket head cap screw.

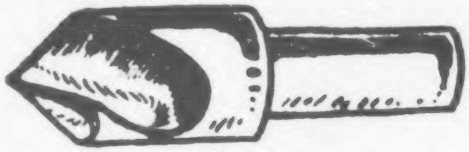
Spotfacing

Spotfacing is done to provide a bearing surface for a nut or bolt head. See figure 4. A counterbore is generally used, but for inverted spotfacing, a special tool is used.

Figure 4 Sectional view of a casting with a mounting hole that has been spotfaced. A bolt head cannot seat on an uneven surface unless it is spotfaced.

Countersinks

Countersinks are made in two standard angles, 100 degrees and 82 degrees included. The 82 degrees countersink is the most used in machine shops as 100 degree screws are used mostly in aircraft manufacture. See figure 5.



The screw head should be flush with the surface or slightly below, depending on the application. See figure 6.

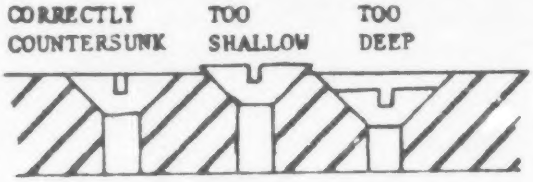
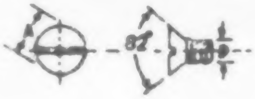


Table 1 gives 82° screw head diameters. You can determine the depth with this table; however, if a flat head screw is available, a frequent check can be made while you are making the countersink. Countersinks are also used to chamfer holes. When counterboring for socket head cap screws, it is generally important to make it deep enough to bring the top of the head flush with the surface or slightly lower.

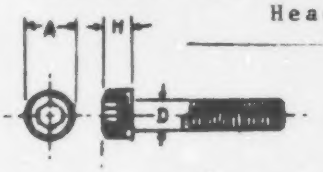
Table 1 Machine Screws



Nom. Size	Basic D	Max. A Sharp
0	.0600	.119
1	.0730	.146
2	.0860	.172
3	.0990	.199
4	.1120	.225
5	.1250	.252
6	.1380	.279
8	.1640	.332
10	.1900	.385
12	.2160	.438
1/4	.2500	.507
5/16	.3125	.635
3/8	.3750	.762
7/16	.4375	.812
1/2	.5000	.875
9/16	.5625	1.000
5/8	.6250	1.125
3/4	.7500	1.375

Table 2 will give you the head depth; however, if a bolt is available, you may use it for checking the hole.

Table 2. American Standard Hexagon Socket Head Cap Screws



Nominal Size	Body Diameter D	Head Diameter A	Head Height H
0	0.0600	0.096	0.060
1	0.0730	0.118	0.073
2	0.0860	0.140	0.086
3	0.0990	0.161	0.099
4	0.1120	0.183	0.112
5	0.1250	0.205	0.125
6	0.1380	0.226	0.138
8	0.1640	0.270	0.164
10	0.1900	5/16	0.190
1/4	0.2500	3/8	1/4
5/16	0.3125	15/32	5/16
3/8	0.3750	9/16	3/8
7/16	0.4375	21/32	7/16
1/2	0.5000	3/4	1/2
5/8	0.6250	15/16	5/8
3/4	0.7500	1 1/8	3/4
7/8	0.8750	1 5/16	7/8
1	1.0000	1 1/2	1

Special Counterbores

Special counterbores are sometimes made in the shop, using a H.S. lathe tool bit for a cutter. The example shown in figure 7 has a 1/2" pilot, a 3/4" shank, and a 1/4" tool bit. The hole for the tool bit is drilled about 1/32" under the diagonal dimension and the tool is tapped through the hole with a soft hammer. A 1/4" - 20 thread is made in the end for a setscrew. A gash is ground for tool and chip clearance on the cutting side. The tool is ground with rake and clearance angles and inserted with the amount extending necessary to produce the hole diameter required. Other sizes may be made in the same manner. Another method of making a counterbore is to use a square end drill in a hole drilled with a standard drill just under the full depth required. See figure 8.

A countersink or counterbore may be operated at the same RPM as a comparative size drill. Cutting oil should be used on counterbores as it lubricates the pilot to some degree.

7

Shop Made Counterbore

Figure 8. To square off the bottom of a drill hole, regrind a stock drill. Square the end of the drill and grind lip clearance. Drill first with a stock drill of the same size, then with the flat bottom drill.

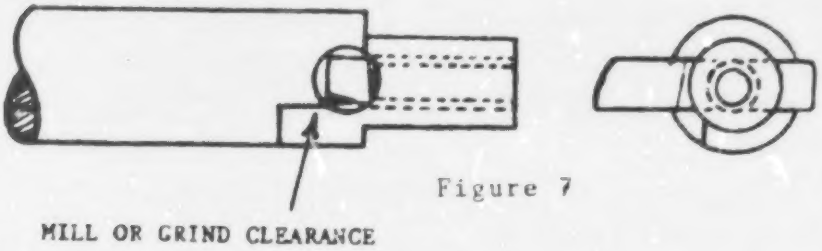


Figure 7

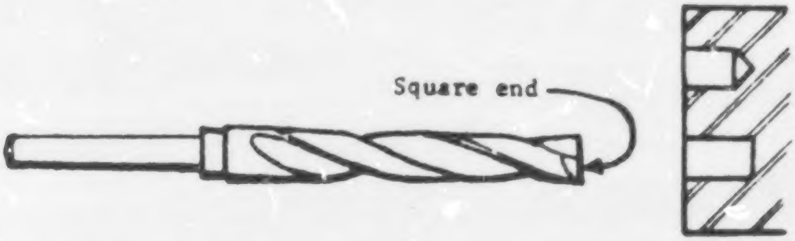


Figure 8

SELF-CHECK FOR ENABLING OBJECTIVE 1

number

PAGE 10 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. What is a countersink used for?
2. What is a counterbore used for?
3. What is the included angle of a countersink for American standard machine screws?
4. What could you do if your set of standard counterbores would not produce the hole size that you needed?
5. How could you determine the proper depth for a countersink screw head?
6. What is the purpose of spotfacing?
7. What tool is used for spotfacing?
8. What are combination drills?

Now check your answers with the Answer Key.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number
ANSWER KEY

PAGE 11 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

1. For chamfering holes and for cutting countersink holes for screw heads.
2. For producing an enlarged hole on one end of an existing hole.
3. 82 degrees
4. Make a special tool in the shop.
5. By using the table or by trial and error with the screw head.
6. To provide a machine surface for a bolt head.
7. A counterbore usually.
8. Drills that are ground for a special purpose with several steps.

All of your answers should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2

number

PAGE 12 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective:

Practice countersinking, counterboring and spotfacing.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1, practice countersinking, counterboring and spotfacing.	1. a. Drill Press b. Stock
2. Complete the Self-Check. Have your instructor check your work.	2. Self-Check enclosed.
3. When you think you can perform this task, take the Performance Test.	3. Performance Test.

SELF-CHECK FOR ENABLING OBJECTIVE 2 number PAGE 13 OF 15

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your work by answering the items below. All items should receive a YES response.

	YES	NO
1. Were two 1/4" holes drilled in the steel?		
2. Was a counterbore made using the designated RPM and cutting fluid?		
3. Was workpiece checked frequently for proper depth with the bolt head?		
4. Was a countersink made?		
5. Was workpiece checked frequently checking with the screw head for the correct depth?		
6. Was the scrap material set on a 10° angle in the drill press?		
7. Was the piece drilled through while it was on a 10° angle with the drill press table?		
8. Was the hole spotfaced using the counterbore?		
9. Was the spotface made a complete circle, but no deeper?		

If you received a "NO" response for any item, go back and repeat one or more of the Learning Activities for this Enabling Objective.

PERFORMANCE TEST FOR 2 | 0 4

duty task number

PAGE 14 OF 15

DIRECTIONS:

Given access to a drill press, you will countersink, counterbore and spotface. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were two 1/4" holes drilled in the steel?		
2. Was a counterbore made using the designated RPM and cutting fluid?		
3. Was workpiece checked frequently for proper depth with the bolt head?		
4. Was a countersink made?		
5. Was workpiece checked frequently checking with the screw head for the correct depth?		
6. Was the scrap material set on a 10° angle in the drill press?		
7. Was the piece drilled through while it was on a 10° angle with the drill press table?		
8. Was the hole spotfaced using the counterbore?		
9. Was the spotface made a complete circle, but no deeper?		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained
☐ Not attained

EVALUATOR

DEPT.

PROG.

DUTY

TASK

DEPT.

PROG.

Instructional Resources

Audiovisuals

------Bergwall Productions, Garden City, New York, 1980.

Countersinking and Counterboring

KNOWLEDGE TEST FOR 2 | 0 4

duty task number

PAGE 1 OF 1

DUTY | TASK | DEPT. | PROG.

TASK:

Perform Counterboring, Countersinking and Spotfacing

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. Spotfacing is done with a
   a. counterbore.
   b. combination drill.
   c. countersink.
   d. all of the above.

2. A countersink is used for
   a. making seats for flat head screws.
   b. drilling holes in counters.
   c. enlarging a hole to recess a bolt head.
   d. none of the above.

3. How can you produce a non-standard counterbore?
   a. With a combination drill.
   b. By grinding a drill flat and squaring the bottom of the hole.
   c. By making a tool.
   d. All of the above.

4. A counterbore is used for
   a. making seats for flat head screws.
   b. enlarging holes to recess a bolt head.
   c. boring holes in counters.
   d. none of the above.

5. The included angle of a countersink for American standard machine screws is
   a. 100 degrees.
   b. 82 degrees
   c. 60 degrees.
   d. none of the above.

STUDENT LEARNING GUIDE

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

PROGRAM: MACHINE SHOP

DUTY: 3 OPERATING A LATHE

TASK: 0 5 Use Three Jaw Chuck

PURPOSE:

The three-jaw universal chuck is a self-centering work-holding device. To understand the principles and know how to use the three jaw chuck will be of great value to you as you seek to be a machinist. Understanding the principles and knowing how to use the three-jaw chuck is a requirement of a machinist.

PLEASE DO NOT WRITE IN LEARNING GUIDE

DUTY
TASK
PREREQ.
DEPT.
PROG.
REVISED

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

DUTY

TASK

DEPT.

PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance,
and standard)

GIVEN: access to a lathe, three jaw chuck, and a blueprint,

YOU WILL: use three jaw chuck.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the steps in installing collets and chucks.
2. Install collets and chucks.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1 number

PAGE 4 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective

Identify the steps in installing collets and chucks.

PROCEDURE

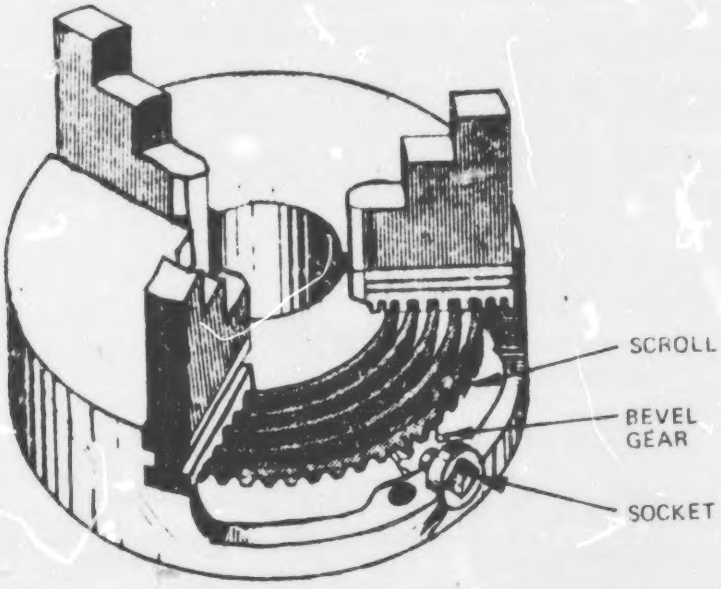
LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1.	1. a. Text: Machine Tool Operations Visutext, pages 96-100. b. Instruction Sheet enclosed, The Three Jaw Chuck c. Instruction Sheet enclosed, Installing Workpiece in Three Jaw Chuck
2. View Resource No. 2.	2. Bergwall filmstrip and cassette: "The Three and Four Jaw Chucks"
3. Complete the Self-Check.	3. Self-Check enclosed.
4. Go on to Enabling Objective No. 2.	

The Three-Jaw Chuck

The three-jaw universal chuck is a self-centering device used to grip round and hexagonal stock. It is termed "universal" because all three jaws move simultaneously by rotating one of the three bevel-gears with a chuck wrench. This simultaneous motion is caused by the bevel-gears on the chuck wrench socket which mate with the bevel-gear on one side of the scroll plate. The opposite side of the scroll plate has thread-like grooves into which the three jaws fit. See figure 1. Thus, when the bevel-gear is turned with the chuck wrench, the scroll is turned and the chuck jaws move in or out depending upon the direction the chuck wrench is turned.

Since the scroll is a thread-like groove and engages the jaws to move them, the jaws cannot be reversed as they are with a four-jaw chuck.

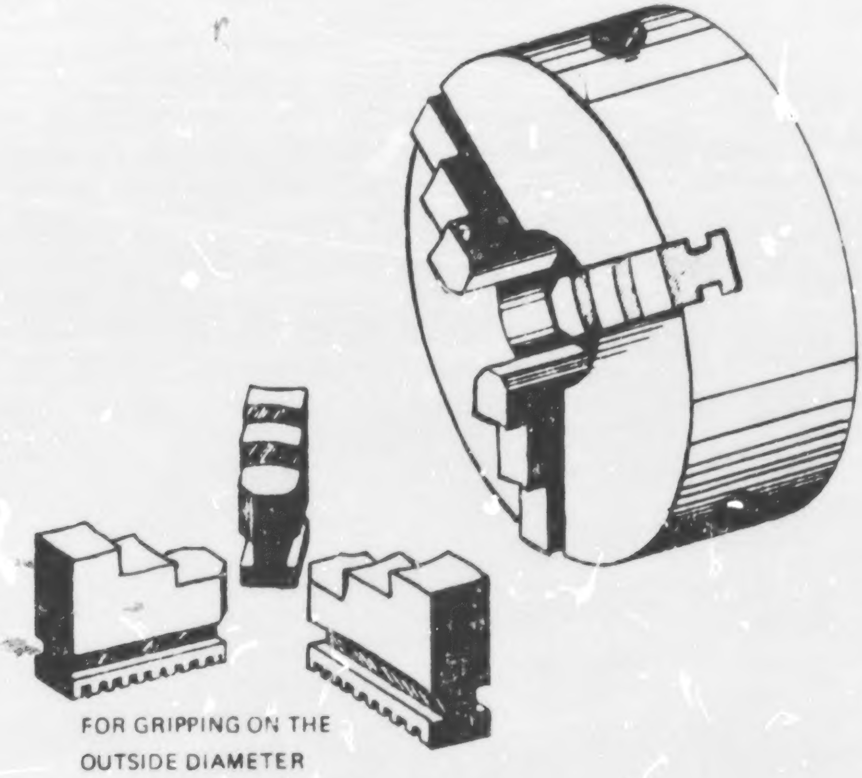
Figure 1



There are two types of three-jaw chucks. One type, the standard three-jaw chuck, requires two sets of jaws, figure 2; one for gripping the workpiece on the inside diameter, and the other set for gripping the workpiece on the outside diameter.

To change jaws in the standard three-jaw chuck, remove the jaws by turning the chuck-key counterclockwise until all the jaws are free of the scroll. They will come out in the order -3,2,1.

Figure 2

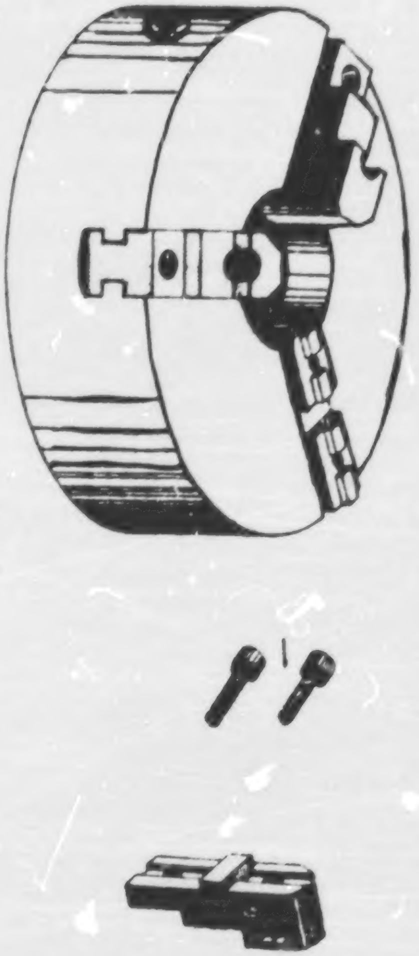


Installing the Jaws:
First, clean the threads in solvent, oil lightly, then replace the jaws in the reverse order -1,2,3. Place No. 1 jaw in No. 1 slot of the chuck, being sure the thread of the jaw is pushed against the scroll, and the scroll end is just short of the slot of the jaw. Turn the scroll with the chuck-key until the scroll is engaged with chuck jaw. Repeat this procedure with 2 and 3.

NOTE: You will find the numbers stamped at the edge or inside the slot of the chuck and on the jaws. The number of the jaw and slot must be the same, otherwise, the jaws will not close properly causing the workpiece to run eccentric. Also, the jaw sets of three-jaw chucks are not interchangeable with other three-jaw chucks. You will find the chuck number, which is stamped on the chuck on each jaw.

The other type has a two-piece jaw, figure 3. The bottom section of the jaw, which is engaged with the scroll is called the master jaw and is not removed from the chuck unless it is necessary to clean the scroll. The top section is called the top-jaw and is secured to the master-jaw by two allen-head cap screws. When changing the jaws to grip work on the outside or inside diameter of the workpiece, the two allen-head cap screws are removed, the top jaw is reversed, the allen-head cap screws are replaced and the chuck is ready for use.

Figure 3



NOTE: When the top-jaws are reversed, the mating surfaces must be wiped clean. If any chips or dirt are present, accuracy will be impaired and possible damage to the jaws could occur.

Soft Jaws:
One very distinct advantage of the two-piece jaw is that the hard top jaw can be replaced by a set of soft jaws.

Many times it is necessary to hold workpieces in a three-jaw chuck on previously turned diameters without damaging the surface and hold concentricity to a close tolerance on diameters to be turned. For this type of work, soft jaws are employed. Soft jaws are made of either mild steel or aluminum, and are turned or bored to suit the outside or inside diameter of the workpiece to be machined.

Accuracy of the Three Jaw Chuck:

A new chuck may hold stock with as little run-out (concentricity) as five ten thousandths of an inch (.0005) but, with use, will lose this accuracy. If a chuck has the proper use and care, over a period of time, the run-out (concentricity) should not exceed three-thousandths of an inch (.003). To maintain the accuracy of the chuck, the following points should be observed:

1. Be sure the mating surfaces of the lathe spindle and the chuck are clean and free of dirt chips,
2. Keep the scroll clean,
3. Do not over-tighten the chuck,
4. Tighten the chuck with all three sockets,
5. Always have three teeth of the chuck jaw in contact with the scroll,
6. The workpiece should be long enough so the material is gripped by the full length of the jaws and,
7. Avoid polishing the workpiece with emery paper.

Installing Workpiece in Three-Jaw Chuck

When installing the workpiece in the chuck, there are several points which should be followed. They are:

1. Open the chuck jaws enough to allow the workpiece to enter. Then, with the chuck wrench, close the jaws on the workpiece only tight enough so that you can rotate and move the workpiece up and down slightly. This will help center the workpiece and provide maximum gripping pressure.
2. To provide maximum rigidity, never extend the workpiece from the chuck jaws any farther than necessary. There is a rule-of-thumb which states the workpiece should never be extended from the chuck more than three times its diameter. The exception to this rule would be when a center drilling operation is being performed, a steady rest is being used to support the outer end of the workpiece, or the workpiece being turned is supported by a center in the tailstock of the lathe.
3. Workpieces with a rough or tapered surface cannot be held securely. Therefore, extreme caution must be taken when attempting to machine workpieces of this type.

Cleaning the Scroll:

When chips and dirt get into the scroll, the chuck will turn hard and may be damaged if it is not cleaned. This is done by removing the jaws and brushing out the jaw threads in solvent. The scroll may be cleaned by using a piece of fiber or hardwood shaped to fit the scroll. By slowly turning the scroll while holding the cleaning tool in the groves, most of the impacted dirt and chips will be removed. Repeat this action several times and wipe out the slots with a cloth. Oil lightly and replace jaws. Do not use compressed air to clean a chuck as it may blow chips and dirt behind the scroll plate into the bevel-gears that turn it.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number PAGE 10 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. The three-jaw universal chuck is a ______________ __________ device.
2. The three-jaw chuck is used to grip ____________ and __________ stock.
3. Since the ___________ is like a thread, the jaws cannot be reversed in the three-jaw chuck.
4. The bottom section of the two-piece jaw is called the __________ jaw.
5. The top section of the two-piece jaw is called the __________.
6. The purpose of soft jaws is to prevent __________ to previously turned diameter, and to maintain _________________.
7. Soft jaws are made of ______________ and ________________.
8. The accuracy of a three-jaw chuck should not exceed ____________ with proper used and care.

9

9. List five points which will help maintain the accuracy of the tree-jaw chuck.
a. ______________________________
b. ______________________________
c. ______________________________
d. ______________________________
e. ______________________________

10. Workpiece with a ____________ or ____________ surface cannot be held in a three-jaw chuck.

Now check your answers with the Answer Key.

BEST COPY AVAILABLE

SELF-CHECK FOR ENABLING OBJECTIVE ANSWER KEY

1
number

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

1. self-centering

2. round and hexagonal

3. scroll

4. master

5. top jaw

6. damage and to maintain concentricity

7. mild steel and aluminum

8. three-thousandths (.003)

9. a. Be sure the mating surfaces of the lathe spindle and the chuck are clean and free of dirt and chips.

   b. Keep the scroll clean.

   c. Do not over-tighten the chuck.

   d. Tighten the chuck with all three sockets.

   e. Always have three teeth of the chuck jaw in contact with scroll.

   f. The workpiece should be long enough so the material is gripped by the full length of the jaws.

   g. Avoid polishing the workpiece with emery paper.

All of your answer should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2

number

PAGE 13 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective:

Install collets and chucks.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1. practice installing collets and chucks.	1. a. Lathe b. Collets and chucks
2. Complete the Self-Check. Have your instructor check your work.	2. Self-Check enclosed.
3. When you think you can perform this task take the Performance Test.	3. Performance Test.
4. See your instructor for a Job Plan Sheet.	

SELF-CHECK FOR ENABLING OBJECTIVE 2 number PAGE 14 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your work by answering the items below. All items should receive a "YES" response.

	YES	NO
1. Was stock cut on horizontal band saw (for all details)?		
2. Was stock mounted for each detail using the following operations		
turned and faced?		
centered and drilled?		
knurled?		
angled turning?		
drilled tap?		
used die?		

NOTE: On the knob eliminate the hex and just knurl.

If you received a "NO" response for any item go back and repeat one or more of the Learning Activities for this Enabling Objective.

PERFORMANCE TEST FOR 3 | 0 5

duty | task number

PAGE 15 OF 16

DIRECTIONS:

Given access to a lathe and a three jaw chuck, you will use three jaw chuck. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Was stock cut on horizontal band saw (for all details)?		
2. Was stock mounted for each detail using the following operations		
turned and faced?		
centered and drilled?		
knurled?		
angled turning?		
drilled tap?		
used die?		
NOTE: On the knob eliminate the hex and just knurl.		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained

☐ Not attained

EVALUATOR

DEPT.

PROG.

LIST OF RESOURCES, MATERIALS, AND EQUIPMENT

PAGE 16 OF 16

DUTY

TASK

DEPT.

PROG.

Instructional Resources

Texts

Krar, S., Oswald, J.W., & St. Amand J., Machine Tool Operation, Visutext, McGraw-Hill Publishing Co., New York, 1983.

Audiovisuals

------- Bergwall Productions, Garden City, New York, 1980.

KNOWLEDGE TEST FOR	3	0	5
	duty	task number	

PAGE 1 OF 1

TASK:

Use Three Jaw Chuck

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

DUTY

TASK

DEPT.

PROG.

1. The three-jaw universal chuck is a __________ ___________ device.

2. The three-jaw chuck is used to grip _____________ and _________ stock.

3. Since the ____________ is like a thread, the jaws cannot be reversed in the three-jaw chuck.

4. The bottom section of the two-piece jaw is called the __________________ jaw.

5. The top section of the two-piece jaw is called the____________.

6. The purpose of soft jaws is to prevent ________________ to previously turned diameter, and to maintain __________________.

7. Soft jaws are made of _______________ and _______________.

8. The accuracy of a three-jaw chuck should not exceed_____________ with proper used and care.

9. List five points which will help maintain the accuracy of the three-jaw chuck.

10. Workpiece with a __________ or ______________ surface cannot be held in a three-jaw chuck.

STUDENT LEARNING GUIDE

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

DUTY | TASK | PREREQ. | DEPT. | PROG. | REVISED

PROGRAM: MACHINE SHOP

DUTY: 3 OPERATING A LATHE

TASK: 1 4 Use Knurling

PURPOSE:

A machinist is often required to do knurling operations, therefore a knowledge of knurling is essential. Knurling is used in lathe work to decorate a workpiece, to make an otherwise smooth surface safer to handle, and to change the size of a workpiece.

PLEASE DO NOT WRITE IN LEARNING GUIDE

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

OBJECTIVES

PAGE 3 OF 16

DUTY

TASK

DEPT.

PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance, and standard)

GIVEN: access to knurling tool and lathe.

YOU WILL: use knurling.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the steps in knurling.
2. Practice knurling.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1 number

PAGE 4 OF 16

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

Enabling objective:

Identify the steps in knurling.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1.	1. a. Text: Machine Tool Operations Visutext, pages 84-85. b. Instruction Sheet enclosed, Types of Knurling Tools
2. Use Resource No. 2 to identify the steps in knurling	2. a. Bergwall filmstrip and cassette, "Knurling on a Lathe" b. Instruction Sheet enclosed Knurling Procedure
3. Complete the Self-Check.	3. Self-Check enclosed.
4. When you think you can attain this task take the Knowledge Test.	4. Knowledge Test.
5. Go on to Enabling Objective No. 2.	

Types of Knurling Tools

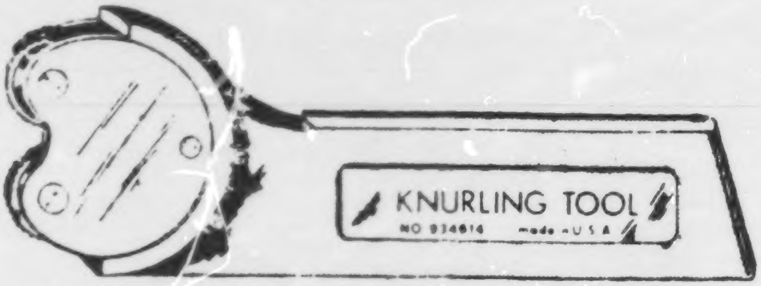
Knurling is the process of forming a diamond or straight pattern on the outside or inside surface of a workpiece. The purpose of knurling is to (1) improve the surface appearance, (2) provide a better grip, and (3) to change the diameter of a workpiece. Many tool handles such as punches and tap handles are knurled with a diamond pattern to provide a better grip as well as appearance. Shafts which have a bearing diameter worn undersize are knurled to bring the diameter back to its proper size to retain the bearing. However, due to the diamond pattern on the knurl, there will not be as much surface area in contact with the bearing, resulting in less holding power than the original solid surface would give.

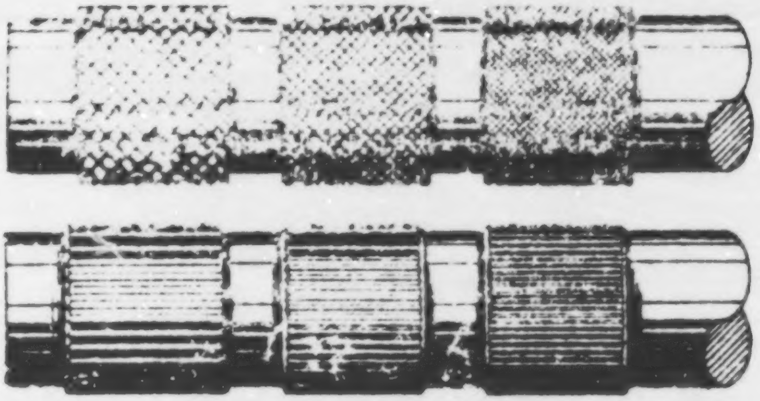
A straight knurl is used on some pulley shafts, automobile door handles, and windshield wiper shafts. The straight knurl acts as a small tooth spline and gives good holding power.

Lathe Knurling Tools:

The knurling tool shown in figure 1 is a tool post type on which a pair of hardened steel rolls are mounted.

Figure 1

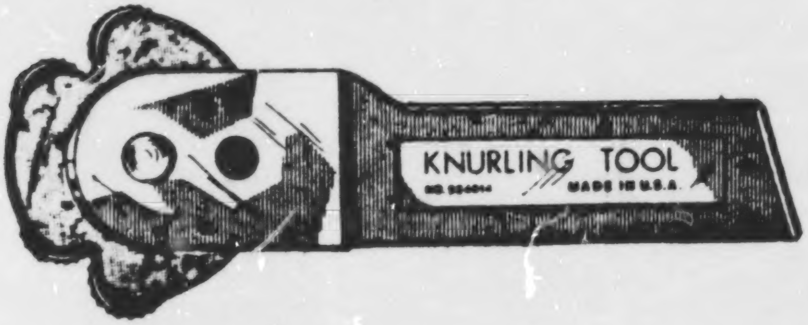




These rolls may be obtained in coarse, medium, and fine pitches.

Figure 2.

Some knurling tools are made with the coarse, medium, and fine rolls mounted on one holder, figure 3.



Knurling Suggestions:

Since knurling forms the metal rather than cutting, very high tool pressure is produced which in turn causes two problems. They are: springing of the workpiece and surface hardening. To maintain rigidity, small diameters are turned after the knurling operation has been completed. To prevent surface hardening, make your cut deep enough to finish the knurl in one pass if possible. A knurl cannot be improved after the pattern has formed a peak, ending in a point. Further knurling will damage it. The knurling tool should not be backed away from the part until the knurl is complete as the rolls may not mesh with the original grooves on the part.

When knurling tough materials, like high-carbon steel, alloy steel, and/or slender workpieces, it may be necessary to set the knurling tool at a slight angle to the work surface to concentrate the pressure on a smaller area.

See Figure 4 in next page.

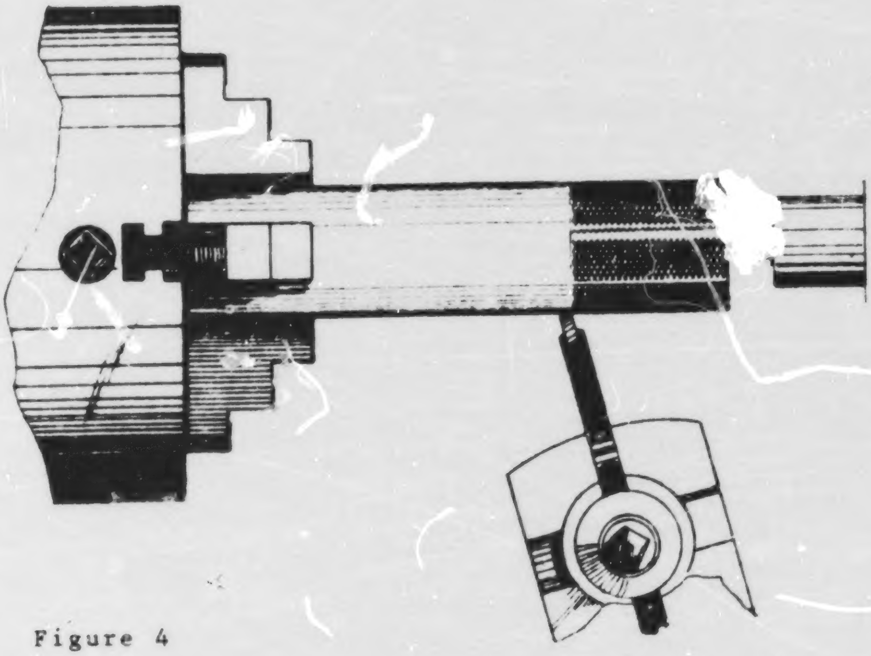


Figure 4

Lubrication:

A lubricant is used to provide a better surface finish, dissipate the heat, and wash away the metal particles which disengage themselves from the parent metal. The lubricant may be a cutting oil or a full-flow of soluble oil.

Chucking on the Knurl:

When a workpiece has to be chucked on the knurled portion, use soft material such as copper or aluminum to protect the knurl from damage.

Knurling Procedure

1. Mount and center workpiece in four-jaw chuck.
2. Insert drill chuck in the tailstock spindle.
3. Insert center drill in drill chuck.
4. Center drill the workpiece, use a cutting fluid for lubrication.
5. Remove center drill from drill chuck.
6. Remove drill chuck from tailstock spindle.
7. Insert live-center in tailstock spindle.
8. Position the tailstock and clamp in place.
9. With the tailstock handwheel extend the tailstock spindle so the live-center is positioned in the center hole of the part.
10. Mount tool post assembly, including left-hand offset tool holder and right-hand turning tool.
11. Select and set proper R.P.M.
12. Select and set proper feed.
13. Turn the workpiece to the desired diameter.
14. Remove turning tool from tool holder and tool holder from the tool post.
15. Remove the live-center in tailstock spindle.
16. Insert a dead-center in tailstock spindle.
17. Coat the dead-center with a center lubricant.
18. Adjust tailstock spindle so the dead-center is positioned in the center hole of the part.
19. Mount the knurling tool post. Be sure the roller head is at or near the center of its radial adjustment and right angle to the post.

20. If the knurl runs close to the chuck jaws, move the carriage toward the chuck until the knurling tool is in the position to satisfy the length of the knurl. With the spindle in neutral, rotate the chuck by hand to make sure the chuck jaws clear the cross-slide and compound rest.

21. Return the carriage so the knurling tool is at the right end of the workpiece.

22. Set the correct R.P.M. -approximately one fourth of the R.P.M. for turning.

23. Set the correct feed -approximately .010 per revolution.

24. Make sure the carriage feeds from right to left.

25. With the spindle turning, move the cross-slide in until the knurl rollers make full contact with the part, then move in a depth of .020 to .025.
Do not engage the power feed until a sharp pattern is evident.

26. Engage the power feed.

27. Keep cutting oil or a flood of coolant if available on the knurl.

28. If you want to check your knurl, stop the lathe without disengaging the feed or the cross-slide.

29. If the diamond pattern does not come to a point after the first pass, feed the tool .010" deeper, reverse the feed and make another pass.
Do NOT back the tool out until the knurl is finished.

30. When the knurl is complete, disengage the feed, back out the tool, and stop the lathe. Do not let the knurling tool dwell in one place on a finished knurl. It will produce a distinct line around the periphery of the part.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number PAGE 1[illegible] OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS·

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. What are the two basic kinds of knurls?
2. Each kind is broken down into three categories; what are they?
3. What kind of machining process is knurling? (for example: making a thread with a die is a cutting process.)
4. Why is cutting fluid recommended for knurling?
5. What speed is used in knurling?
6. What feed will you use?
7. How deep should the knurling tool be forced into the work to start the knurl?
8. What is the correct procedure to follow when you come to the mark on your workpiece and you find the knurl is not finished?
9. How do you know when a knurl is finished?
10. a. Give an example: where a diamond knurl would be used.

    b. Do the same for straight knurl.

Now check your answers with the Answer Key.

1. a. diamond knurl
   b. straight knurl

2. a. coarse
   b. medium
   c. fine

3. It is a forming process. A tool is forced into the work where it displaces material which in turn forms ridges.

4. Because of the high pressure involved, a lubricant is necessary to prevent welding between tool and work and to obtain a good surface finish.

5. A very slow speed, usually back gear.

6. A feed of approximately .010 should work fine. On harder materials, the feed may be slowed down to .003" to get a completed knurl in one pass.

7. The knurling tool is brought up to the revolving workpiece and feeding it .020" to .025" deep should give a good knurl.

8. When the first pass over the workpiece doesn't complete the knurl, DO NOT disengage the tool from the work. Stop the lathe and move the feed reverse lever in its opposite position. Now start the lathe again and feed the tool .010" deeper and let it make another pass back over the original knurled surface.

9. When the knurls form a peak ending in a point the job is completed.

10. a. on tool handles

    b. on knobs or to increase a diameter slightly

All of your answer should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2 number

PAGE 12 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

Enabling objective:

Practice knurling.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1, practice knurling.	1. a. Lathe b. Knurling tool
2. Complete the Self-Check. Have your instructor check your work.	2. Self-Check enclosed.
3. When you think you can perform this task, take the Performance Test.	3. a. Performance Test b. Job Plan Sheet

SELF-CHECK FOR ENABLING OBJECTIVE 2 number PAGE 13 OF 16

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

DIRECTIONS:

Evaluate your work by answering the items below.
All items should receive a "YES" response.

	YES	NO
1. Were safety glasses worn?		
2. Was stock cut in horizontal saw?		
3. Was stock faced and center drilled?		
4. Were angles turned (when necessary)?		
5. Was stock drilled and tapped (when necessary)?		
6. Were all sharp edges broken off?		
7. Were diameters knurled (where indicated)?		
8. Was work area cleaned?		

If you received a "NO" response for any item go back and repeat one or more of the Learning Activities for this Enabling Objective.

PERFORMANCE TEST FOR 3 | 1 4

duty task number

PAGE 14 OF 16

DIRECTIONS:

Given access to a lathe and knurling tools, you will use knurling. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were safety glasses worn?		
2. Was stock cut in horizontal saw?		
3. Was stock faced and center drilled?		
4. Were angles turned (when necessary)?		
5. Was stock drilled and tapped (when necessary)?		
6. Were all sharp edges broken off?		
7. Were diameters knurled (where indicated)?		
8. Was work area cleaned?		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained
☐ Not attained

EVALUATOR

DEPT.

PROG.

DUTY

TASK

EN. OBJ.

DEPT.

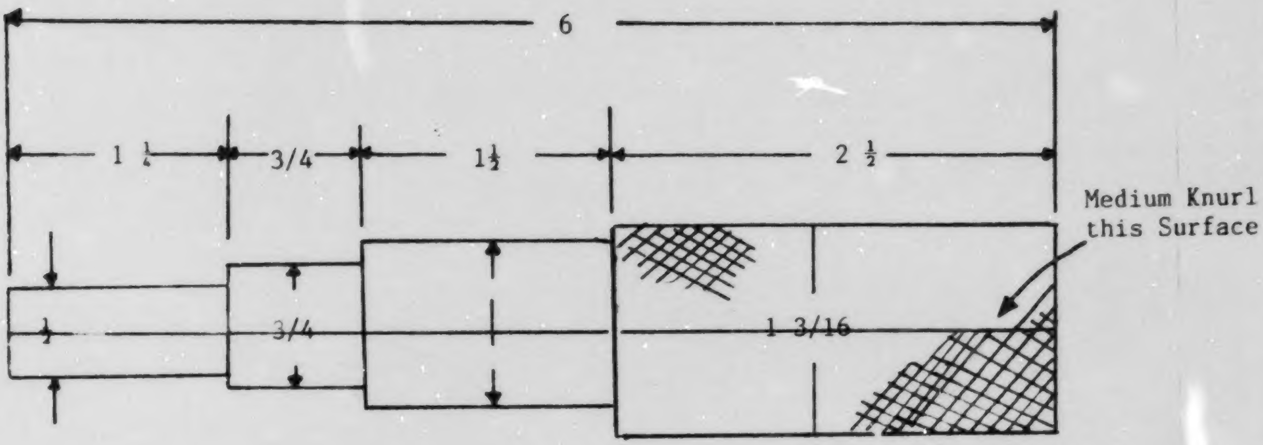
PROC.

Fractional dial--±.015

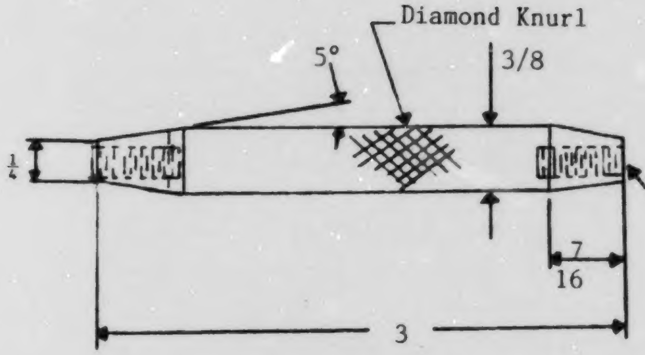
Cold rolled steel--1 required

Handle--1 required

Material--brass 3/8


6
1 1/4
3/4
1 1/2
2 1/2
1/2
3/4
1 3/16

Medium Knurl this Surface


Diamond Knurl
5°
3/8
1/4
7/16
3

No. 21 Drill 5/8 DP.
No. 10-32NF-2-9/16 DP.

Instructional Resources

Texts

Krar, S., Oswald, J. W., and St. Amand, J., *Machine Tool Operations Visutext*, McGraw-Hill Publishing Co., New York, 1983.

Audiovisuals

---Bergwall Productions, Garden City, New York, 1980.

KNOWLEDGE TEST FOR 3 duty 1 4 task number

PAGE 1 OF 1

DUTY

TASK

DEPT.

PROG.

TASK:

Use Knurling

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. Knurling is what kind of an operation?
   a. forming
   b. cutting
   c. shaping
   d. slotting

2. We use a slow speed for knurling; what feed is used?
   a. approximately .010" per rev.
   b. .020" .030" per rev.
   c. .030" .040" per rev.
   d. .040" .050" per rev.

3. When a workpiece is knurled, the diameter
   a. decreases.
   b. stays the same.
   c. increases.
   d. none of the above.

4. The tool should not be backed out from an unfinished knurl because
   a. it may not get back into the original grooves.
   b. the half-nut will not engage at the same point.
   c. the depth of cut would be doubled.
   d. it takes too much time.

5. On work hardening materials, the knurl should be
   a. finished with one pass.
   b. finished with two passes.
   c. half depth.
   d. double depth.

6. Lubricant in knurling is used primarily to
   a. cool the work.
   b. decrease the friction between the work and tool.
   c. protect the surface from oxidation.
   d. none of the above

STUDENT LEARNING GUIDE

THE SCHOOL BOARD
OF PALM BEACH COUNTY, FLORIDA

PROGRAM: MACHINE SHOP

DUTY: 3 OPERATING A LATHE

TASK: 2 0 Perform Taper Turning - Offset

PURPOSE:

The tailstock offset method is used to turn slight tapers on cylindrical workpieces. It is limited to external tapers. Often the practice is used to eliminate a taper on a workpiece.

PLEASE DO NOT WRITE IN LEARNING GUIDE

DUTY
TASK
PREREQ.
DEPT.
PROG.
REVISED

THE SCHOOL BOARD OF PALM BEACH COUNTY

DEPARTMENT OF VOCATIONAL-TECHNICAL EDUCATION

North Technical Education Center
7071 Garden Road
Riviera Beach, Florida 33404

South Technical Education Center
1300 S. W. 30th Avenue
Boynton Beach, Florida 33435

West Technical Education Center
2625 State Road 715
Belle Glade, Florida 33430

E. Miles Bacon, Director of Vocational-Technical Education

Wilma McCarty, Curriculum and Staff Development Specialist

THIS STUDENT LEARNING GUIDE WAS DEVELOPED BY:

Daniel Gerhart, Machine Shop Instructor
North Technical Education Center

The format used in this student learning guide is one of the products developed through a grant from the Division of Vocational Education, Florida Department of Education which designated Ridge Vocational-Technical Center as a state demonstration site for competency-based vocational education.

DUTY

TASK

DEPT.

PROG.

PERFORMANCE OBJECTIVE:
(Include condition, performance,
and standard)

GIVEN: access to a lathe,

YOU WILL: perform taper turning-offset.

HOW WELL: You must successfully complete the Knowledge Test. Your performance will be assessed by your instructor using the Performance Test.

ENABLING OBJECTIVES:

1. Identify the steps in setting up a machine using the tailstock method.
2. Practice taper turning-offset.

BEST COPY AVAILABLE

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 1

number

PAGE 4 OF 16

Enabling objective:

Identify the steps in setting up a machine using the tailstock method.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Read Resource No. 1.	1. a. Text: Machine Tool Operations Visutext pages 86-89. b. Instruction Sheet enclosed, Tailstock Offset Method
2. View Resource film strip and cassette.	2. Bergwall filmstrip and cassette: "Three Ways to Produce a Taper"
3. Complete the Self-Check.	3. Self-Check enclosed.
4. Go on to Enabling Objective No. 2.	

DUTY

TASK

EN. OBJ.

DEPT.

PROG.

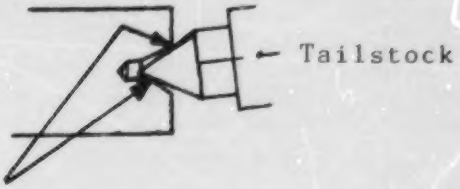
Tailstock Offset Method

Information on the measuring of tapers can be found in the learning guide on Taper Turning-Taper Attachment.

Center holes will wear rapidly as can be seen in Figure 1, because of the limited surface area contact. Be sure you keep the centers well lubricated.

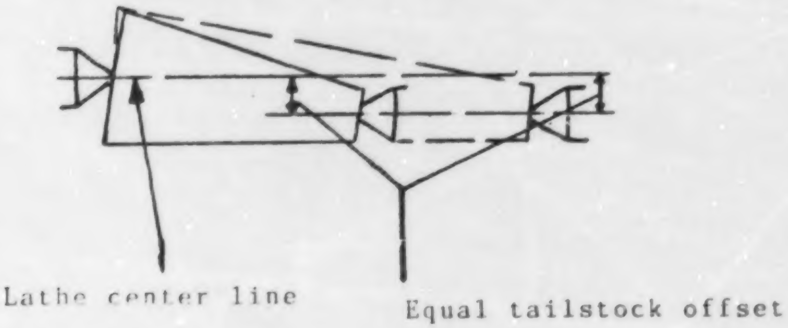
Figure 2 shows how the length of the workpiece affects the taper produced. With the same amount of offset you will get a steep taper on a short workpiece and a slighter taper on a long workpiece.

FIT ON CENTERS
Figure 1



The bearing surfaces are very limited.

Figure 2
INFLUENCE OF LENGTH ON TAPER



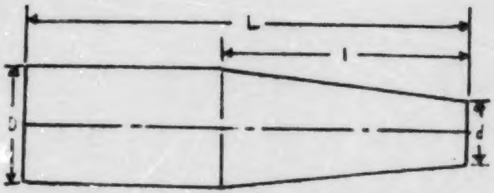
TAPER AND SETOVER CALCULATIONS

Calculating setover when taper per inch is known.
Information needed: TPI = taper per inch. L = Total length of piece.

Formula used: Offset = $\frac{L \times TPI}{2}$

Calculating setover when taper per foot is known.
When the taper per foot (TPF) is known it must be converted to taper per inch (TPI).
The following formula takes this into account.

Offset = $\frac{TPF \times L}{24}$



Basic taper information:
D-Diameter at large end.
d-Diameter at small end.
I-Length of taper.
L-Total length of piece.

TPI= Taper per inch
TPF= Taper per foot

Calculating setover when dimensions of tapered sections are known but TPI or TPF is not given or when tapered length is less than total length.

Formula used:
Offset = $\frac{L \times (D - d)}{2 \times 1}$

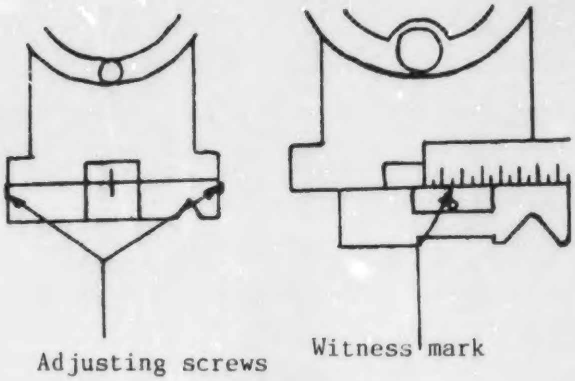
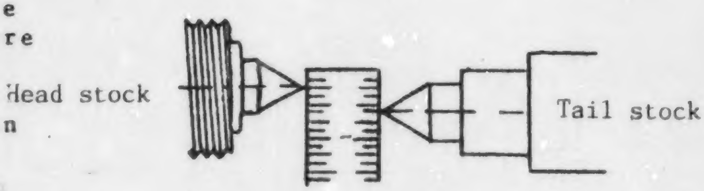


Figure 3

In figure 3 you see how the witness marks on the tailstock are offset using a rule to measure the distance. Before you can make any adjustments loosen the tailstock clamp. Any adjustments made which are measured with a steel rule are not very precise.

Figure 4 shows how a rule can be used to offset the headstock and tailstock centers.



CENTERS AND RULE

Figure 4

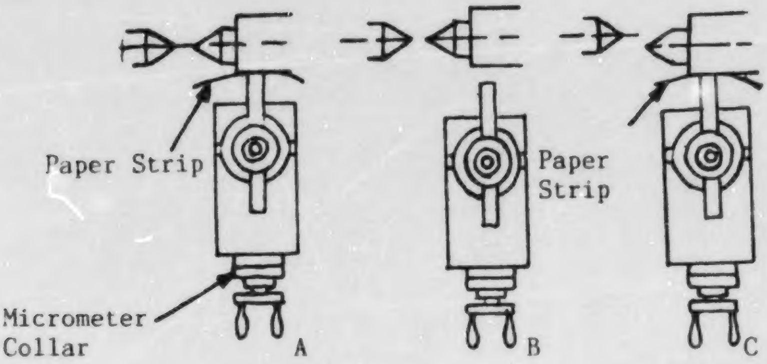
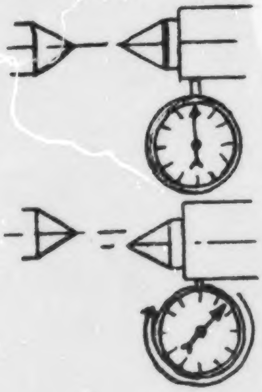


Figure 5

A very accurate method to move the tailstock the predetermined distance is with the cross slide. Figure 5. While the centers are still aligned, bring the toolholder in contact with the tailstock spindle. Use a paper shim as a feeler gage, A. Set the micrometer dial on zero. Then backoff with the cross slide, B, the amount calculated; remove all backlash by backing away farther than necessary and coming toward the lathe centerline to get the calculated distance. Then move the tailstock C, until the paper strip is in contact as in A.

Figure 6 shows how an indicator can be applied to give a precise measurement of the tailstock movement. This is the most accurate method.



Use of dial indicator

Figure 6

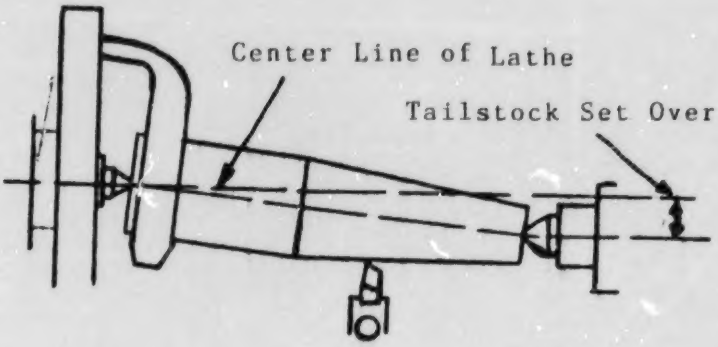

Center Line of Lathe
Tailstock Set Over

Figure 7

Figure 7 is demonstrating a setup for turning a taper. Check to see that the tail of the driving dog is loose and not bound up in the face plate slot.

TAPERED THREADS

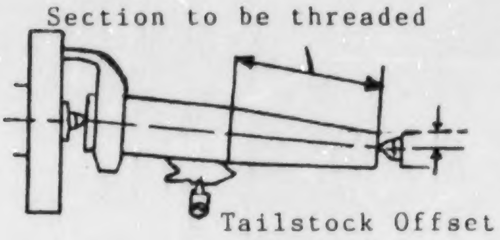

Section to be threaded
Tailstock Offset

Figure 8

The threading tool is setup square to the centerline of the workpiece, not on the tapered part.

The offset tailstock method can also be used when cutting tapered threads like pipe threads. Figure 8.

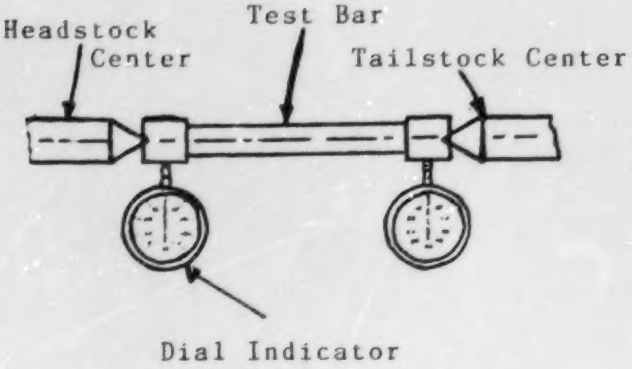

Headstock Center
Test Bar
Tailstock Center
Dial Indicator

Figure 9

ALIGNMENT OF LATHE CENTERS WITH A DIAL INDICATOR

Figure 9 shows how to setup a test bar to return a tailstock to center after the taper is turned. Fasten the dial indicator to the carriage and move from one end of the test bar to other making adjustments until both ends read the same.

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. What kind of tapers can be cut with the tailstock offset method?
2. What are three formulas for tailstock setover to turn a taper?
3. Why is the entire length of the work used in one formula and not the length of the taper?
4. If the taper is given as taper per foot, what formula would you use?
5. Is the offset method better for long or abrupt tapers?
6. List two ways you can measure the amount of offset for the tailstock.
7. How can you measure the taper on a workpiece? List three different ways.
8. How is the work held for turning?
9. How long a taper can be cut with this method?
10. What are some drawbacks in using this method?
11. What is the offset when the TPI is .125" and the total length is 6"?
12. When the large diameter is 2" and the small diameter is 1", the workpiece is 10" long and the tapered section is 5" long, what is the offset?

Now check your answers with the Answer Key.

SELF-CHECK FOR ENABLING OBJECTIVE 1 number
ANSWER KEY

PAGE 11 OF 16

DUTY
TASK
EN. OBJ.
DEPT.
PROG.

1. This method is limited to external tapers and slight tapers.

2. Offset = $\frac{TPI \times L}{2}$, $\frac{TPF \times L}{24}$, or offset = $\frac{L \times (D - d)}{2 \times 1}$

3. Because the total workpiece is offset and not only the tapered part. See Figure 2.

4. Offset = $\frac{TPF \times L}{24}$

5. For long, slight tapers.

6. Use a dial indicator or the graduated crossfeed.

7. With a taper ring gauge, or a micrometer over a specific length, or with a sine plate and gauge blocks.

8. Between centers.

9. As long a piece that will fit between centers.

10. No steep tapers or internal tapers can be made. Center holes are damaged because they do not match the centers while they are offset.

11. Offset = $\frac{TPI \times L}{2} = \frac{.125 \times 6}{2} = \frac{.750}{2} = .375''$

12. Offset = $\frac{L \times (D-d)}{2 \times 1} = \frac{10 \times (2-1)}{2 \times 5} = \frac{10}{10} = 1''$

All of your answers should agree with the answers on the Answer Key. If you missed any, go back and repeat one or more of the Learning Activities for this Enabling Objective.

LEARNING ACTIVITIES FOR ENABLING OBJECTIVE 2 number

PAGE 12 OF 16

DUTY	TASK	EN. OBJ.	DEPT.	PROG.

Enabling objective:

Practice taper turning offset.

PROCEDURE

LEARNING ACTIVITIES	RESOURCES
1. Using Resource No. 1, practice taper turning using the offset method. Have your instructor check your work.	1. Self-Check enclosed.
2. When you think you can attain this task, take the Knowledge Test.	2. Knowledge Test.
3. When you successfully complete the Knowledge Test, take the Performance Test.	3. a. Performance Test. b. Job Plan Sheet.

PERFORMANCE TEST FOR 3 | 2 0

duty task number

PAGE 13 OF 16

DIRECTIONS:

Given access to a lathe and stock, you will perform taper turning-offset. You will be evaluated for attainment of this task based upon the items listed below.

PERFORMANCE STANDARDS ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
1. Were safety glasses worn?		
2. Was a piece of hot rolled, mild steel 1 1/8 x 5 1/8" long cut off?		
3. Were both ends center drilled and faced to an overall length of 5"?		
4. Was lathe dog fastened to your workpiece and set up for between center turning?		
5. Was a right hand tool used to turn the 1" diameter (make it 3" long; measure from the tailstock end)		
6. Was the work reversed and the dog mounted on the finished end (be sure you protect the surface)?		
7. Was the tailstock setover calculated?		
8. Was a dial indicator or the compound rest slide used to offset the tailstock?		
9. Were trial cuts made until the tapered portion was approximately 2" long?		
10. Was the taper per inch calculated?		
11. Were two marks made on the tapered part exactly 1" apart with a scriber?		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained
☐ Not attained

EVALUATOR

DEPT.

PROG.

PERFORMANCE TEST FOR 3 (duty) 2 0 (task number)

CONTINUED

PAGE 14 OF 16

PERFORMANCE STANDARDS

ALL ITEMS MUST BE MARKED YES FOR ATTAINMENT	YES	NO
12. Were the diameters on these marks measured and the smaller subtracted from the larger (This difference should be the same as the answer in step # 9)?........		
NOTE: If it is not, adjust the tailstock and make trial cuts until the result is correct.		
13. Was the workpiece marked 3" from the tailstock end and as many passes as necessary made?........		

DUTY

TASK

ATTEMPT

STUDENT

DATE

☐ Attained

☐ Not attained

EVALUATOR

DEPT.

PROG.

JOB PLAN SHEET

PAGE 15 OF 16

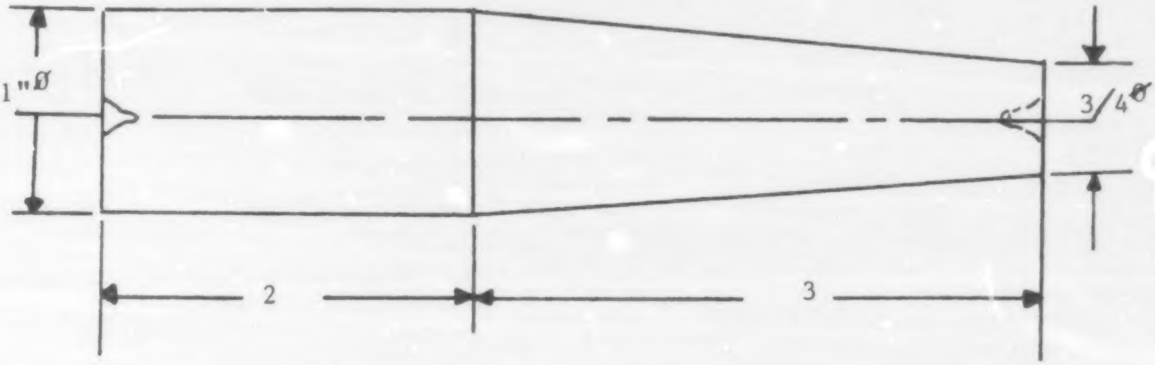
DUTY

TASK

EN. OBJ.

DEPT.

PROC.



Instructional Resources

Texts

Krar, S., Oswald, J.W., and St. Amand, J., Machine Tool Operations Visutext, McGraw-Hill Publishing Co., New York, 1983.

Audiovisuals

---Bergwall Productions, Garden City, New York, 1980.

KNOWLEDGE TEST FOR 3 | 2 0

duty task number

PAGE 1 OF 1

DUTY

TASK

DEPT.

PROG.

TASK: Perform Taper Turning-Offset

DIRECTIONS:

Evaluate your knowledge by answering the items below using a separate sheet of paper.

1. Which of the following tools can be used to measure the tailstock offset?
   a. plug gauge
   b. ring gauge
   c. offset gauge
   d. dial indicator

2. The offset is measured in
   a. inches per yard.
   b. degrees.
   c. thousands per inch.
   d. none of the above

3. The taper can be measured with a
   a. sine bar.
   b. micrometer.
   c. taper ring gauge.
   d. all of the above

4. A smooth finish is obtained by
   a. deep cut and fine feed.
   b. coarse feed and small nose radius on the tool.
   c. shallow cut and coarse feed.
   d. fine feed and small nose radius on the tool.

5. The offset tailstock method is often used to turn
   a. long and small tapers.
   b. tapers that end in a point.
   c. short and steep angle tapers.
   d. long and steep angle tapers.

6. The longest internal taper that can be machined with an offset tailstock is
   a. double the boring length.
   b. the full boring bar length.
   c. half of the boring bar length.
   d. none of the above.